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JULY 1960

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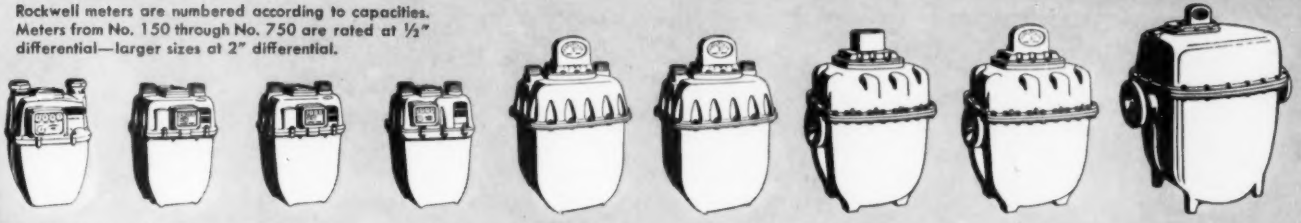

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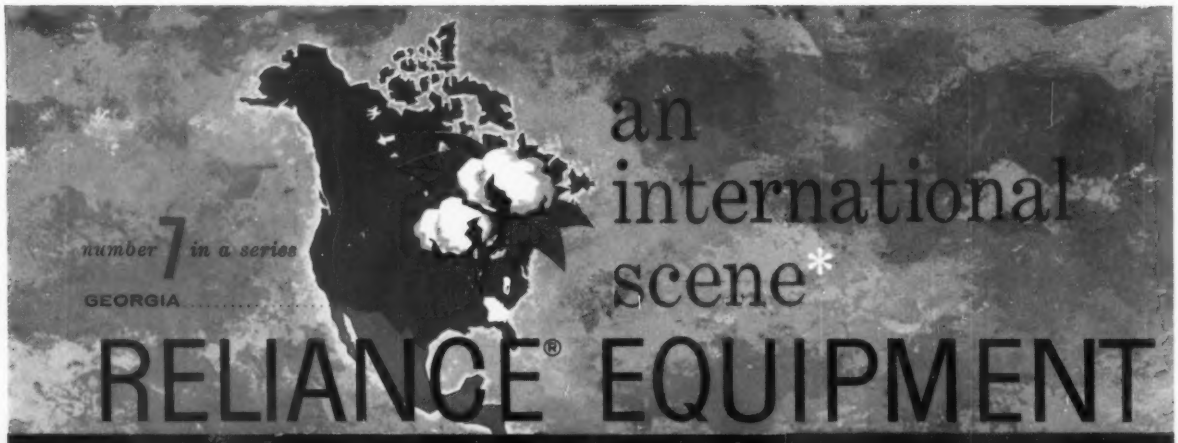

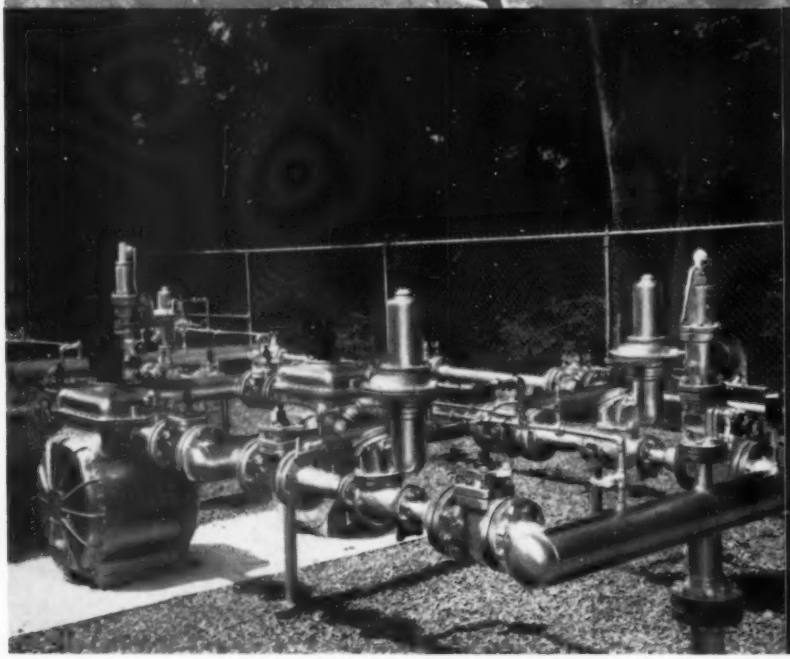

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36TH YEAR OF PUBLICATION

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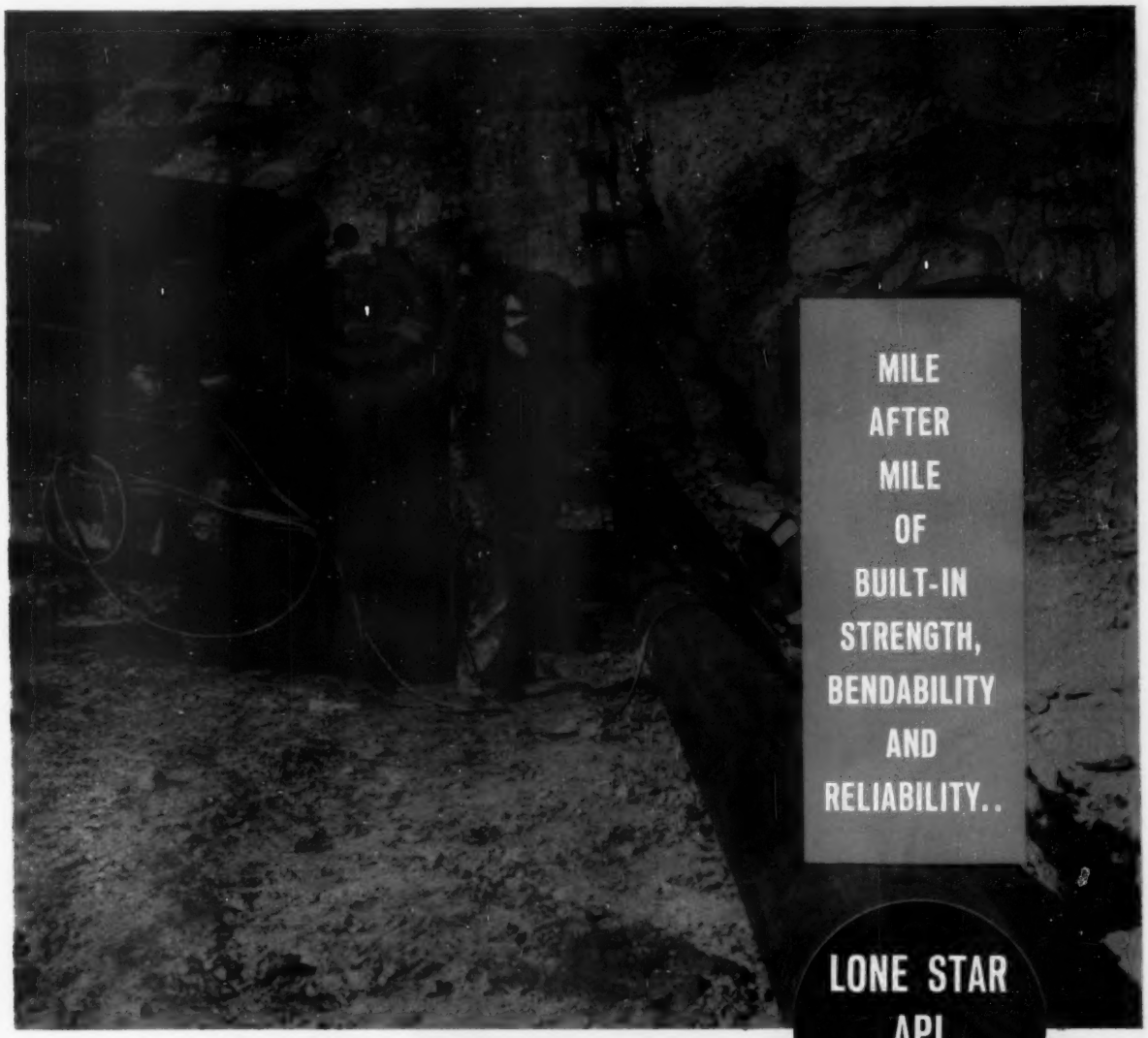

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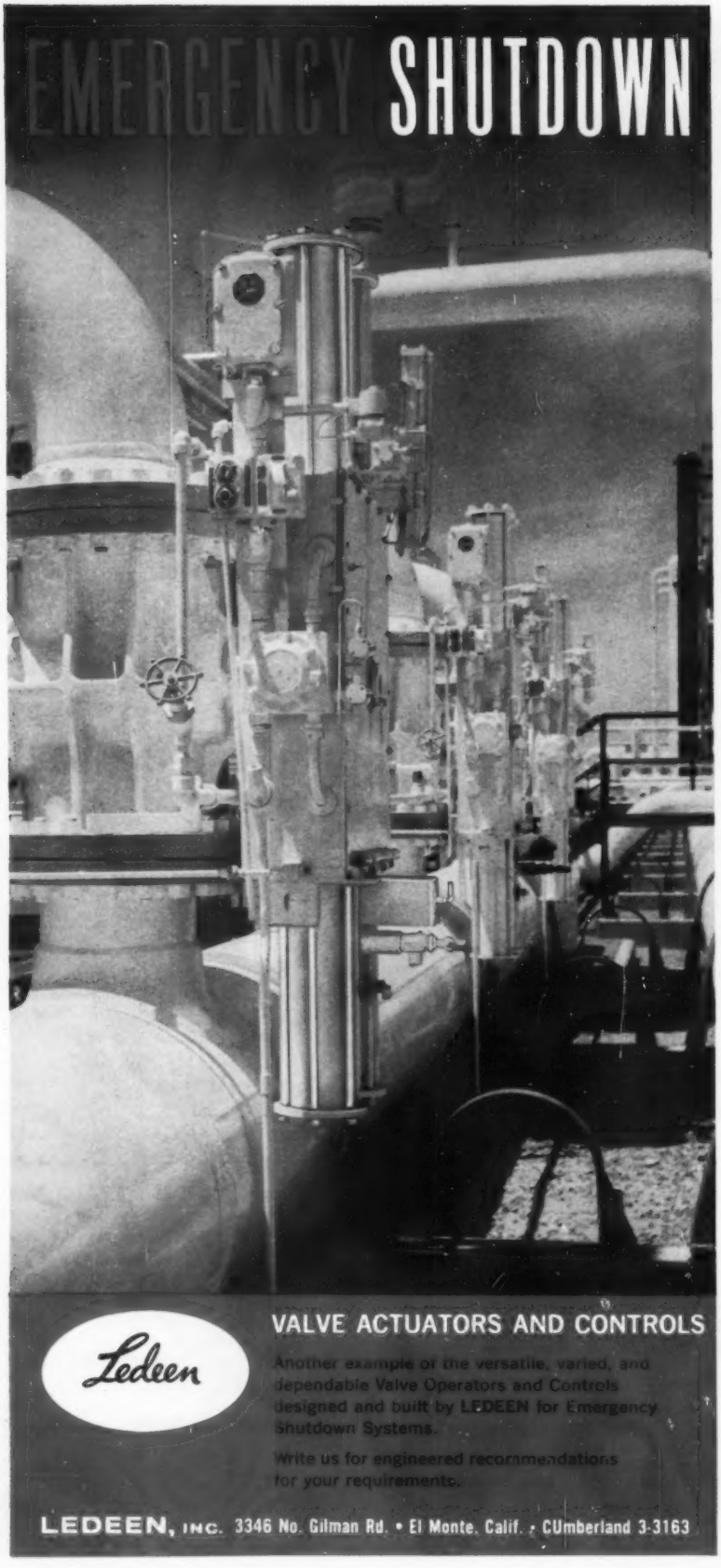
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CALENDAR

August

17-19..Mid-West Gas Association Gas School and Conference — Iowa State College, Ames.

29-31..20th Annual Appalachian Gas Measurement Short Course — West Virginia University, Morgantown, W. Va.

September

12-13..NEGA Gas Utility Managers Conference — Wianno Club, Mass.

12-14..AGA Accident Prevention Conference—Leamington Hotel, Minneapolis.

21-23..Southeastern Gas Association Annual Meeting — Sir Walter Hotel, Raleigh, N. C.

21-23..PCGA Annual Convention — Westward Ho Hotel, Phoenix, Ariz.

22..NEGA Safety Conference—Statler Hotel, Boston

October

4-5..Gas Measurement Institute — National Guard Armory, Liberal, Kan.

5-7..Wisconsin Utilities Association Gas, Electric, Sales & Engineering Convention—Schroeder Hotel, Milwaukee.

10-12..AGA Annual Convention—Atlantic City, N. J.

17-21..National Safety Council Annual Meeting—Chicago.

23-25..Independent Petroleum Association of America Annual Meeting —Statler Hilton, Dallas.

November

1..NEGA Operating Division—Statler Hilton, Hartford, Conn.

14-16..American Petroleum Institute Annual Meeting—Chicago.

15-16..Natural Gas Pipeline Institute—Court Room, Court House, Liberal, Kan.

1961

March

13-17..National Association of Corrosion Engineers Annual Meeting Hotel Statler, Buffalo.

15-17..New England Gas Association Annual Meeting—Hotel Statler, Boston.

20-22..AGA General Management Section Conference—Frances-Marion Hotel, Charleston, S. C.

27-29..Mid-West Gas Association Annual Meeting — Sheraton-Fontenelle Hotel, Omaha.

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GAS

Thermally Thinking

JULY 1960

The gas meter man

"SCIENCE begins and ends with measurement," said Aristotle. "The gas business begins and ends with gas meter men," says Ebdon.

Aristotle's cogent word-magic needs no justification. Perhaps I should substantiate my own.

The simple fact is that gas industry revenues, for the most part, are determined by registration from gas meters—large and small. In addition to determining basic revenues, gas meters are a major part of a gas company's capital investment and operating costs.

Further, gas consumers and companies can tolerate gas meters in only one operating condition. That is —as accurately as man's brains, talents, science and tools can make them perform and still hold a practical relationship with economics.

The key person to successful gas meter performance is your company's GAS METER SUPERINTENDENT. His basic responsibility is to maintain the meters at the highest mechanical and economical standards possible.

This charge is without parallel in an industry having as the very foundation of its commerce the trust and confidence in gas meters on the part of buyer and seller. It is a fact that the gas industry has built a mountain of implied faith that its meters will register a just balance for both parties as our product is exchanged for money.

Meter superintendents and meter men in general are a dedicated lot. This dedication pushes them ever toward a goal of having every meter producing low-cost measurement at zero percentage error at all times. They'll probably never have such an optimum experience; nor will they ever stop seeking it.

I firmly believe that all bureaus of weights and measures could be abolished without any decline in average meter accuracy in nine out of 10 gas utilities today. In fact, I think we would see a continued improvement in this statistic.

An important source of progress and improvement for the art-and-science of gas meter testing and maintenance has been the AGA Metering Subcommittee. Here, gas meter superintendents, and others, exchange meter maintenance technology with their kind. This is where problems of gas meter operations have been solved since 1927. The Metering Subcommittee members have, for example, searched out and passed on the better ways of doing things. They have studied and assessed more automatic methods and equipment for meter shops. They are working toward standardization of meters and parts. They constantly work toward mutually beneficial suggestions and designs with meter manufacturers. And they report and discuss many other things vital to gas metering and, hence, vital to the gas industry. Truly, our industry owes sincere thanks to this subcommittee and the many gas meter superintendents who are serving, or have served, through membership.

While the gas industry should be proud of its gas metering record, this chronicle of industry integrity is not complete. It takes no great foresight to see what lies ahead.

Unhappily, gas meter men are made—they are not born. Hence, in addition to being an administrator, technician, mechanic, and diplomat, meter superintendents are also teachers. Their guidance and policies are vital for the metamorphosis of a bright, three-thumbed young person into a skilled artisan who can feel an ailing meter's pulse and efficiently restore it to peak performance with surgeon-like deftness of hands and tools. Even better men will be needed in our meter shops in the years to come.

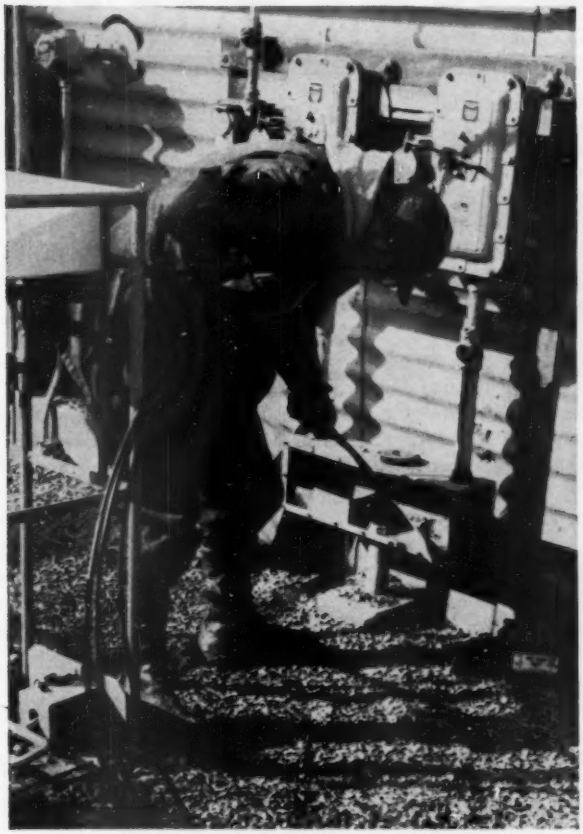
Too, we now enter the era of super-technology. New meter designs are here. New metering devices are next. In the shops, highly sophisticated meter handling, proving, repairing, etc., mechanisms will be required and developed. Surely, electronics will more deeply penetrate meter shops. The impact of highly automated operations will be felt. All will produce their challenge. For, without astute preparation and planning, technical progress can readily become a shambles and a liability.

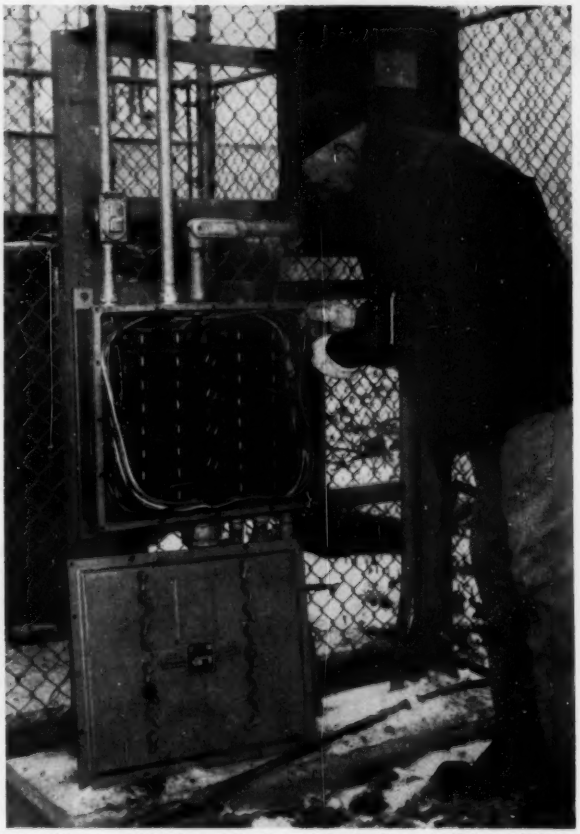
With confidence I say that these challenges will be well handled by gas utilities' meter superintendents through their own spirit and through the accomplishments of the Metering Subcommittee. These are the same factors that have developed these gasmen to their present stature, and have gained our industry's "cash registers" such deserved public confidence.

J. Fred Ebdon
EDITOR

Another new development using

B.F.Goodrich Chemical *raw materials*





New THW wire insulated with Geon is used in sizes up to 3/0 AWG at this new Sohio plant. Wire is made by the Paranite Wire and Cable Division of the Essex Wire Corporation, Marion, Indiana. B.F.Goodrich Chemical Company supplies the Geon vinyl.

"We welcome the higher factor of safety"

. . . of new THW wire insulated with GEON vinyl

These pictures show new wiring going into the Sohio Chemical plant at Lima, Ohio. Here's what the contractor, W. W. Clark Corporation of Cleveland has to say about it:

"In a chemical plant or refinery, electrical wiring often has to go near processing equipment that operates at high temperatures. We try to keep it at least a foot away, but sometimes have to go as close as 6". We welcome the higher factor of safety this new THW wire gives us."

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For information about Geon wire and cable covering, or other ways that Geon improves products or opens new markets, write Dept. GS-4, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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GAS HIGHLIGHTS

Municipals boom in Florida

City governments are seeking a major share of the new natural gas market in Florida. Within a year, the number of municipal gas utilities under construction or in operation has increased from 12 to 24, according to AGA. This contrasts with 17 investor-owned gas distribution systems, but these companies serve far more customers. Voters in St. Augustine voted for the city to take over operation of a distribution system operated by South Atlantic Gas—a defeat for business enterprise.

Oil "major" forms FPC unit

Sun Oil Co., Philadelphia, has formed a new department to cope with "the increasing complexity of federal regulation of its natural gas business." Charles E. Webber will be Director of Natural Gas Administration, the newly formed group that will supervise natural gas sales and related FPC certificate applications, gas rate filings, rate investigations, and related matters.

New Jersey Natural grows

New Jersey Natural Gas (Asbury Park) reports its heating customers have doubled in the past four years. It will add its 50,000th gas heat customer this month. Upsurge has resulted in reduced rates to domestic consumers—gas rates are down 27 per cent while the N. J. price index has risen 23 per cent.

Gas heating up all over

AGA's annual househeating survey shows 1.159 million new gas heating customers were added during 1959—to make a total of 20.2 million—up 6 per cent from '58. Association estimates another 3.9 million gas heating customers will be added by end of 1962—two-thirds will be in new homes, 1.3 million will be converted from other fuels.

Gas companies buy back, resell radio systems

Since 1955, radio communications systems for Southern California and Southern Counties Gas companies have been owned and maintained by Pacific Tel & Tel, which is withdrawing from such operations. Hence, if regulatory approvals are acquired, SoCal and SoCounties will rebuy, and resell the facilities to RCA. Service will be provided the gas utilities by RCA on a lease-maintenance basis.

Quintuple completion off shore

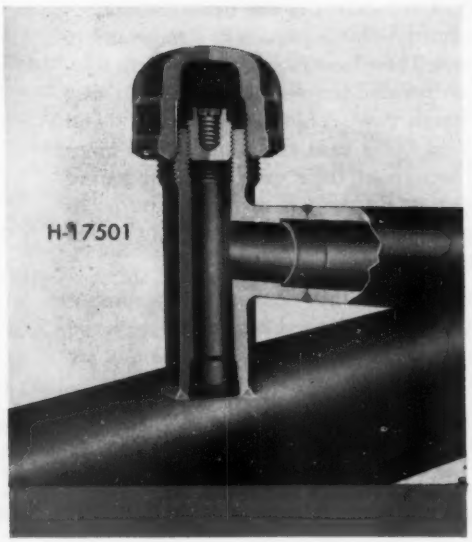
A quartet—Peoples Production Co., El Paso Natural Gas, Sohio Petroleum, and Sinclair Oil & Gas—has made history with a quintuple gas well completion. Five strings of tubing, in one well casing, are producing gas from five producing zones, each at a different depth. The trailblazer is offshore well No. 6, Block 190, about 40 miles from Louisiana's shore, in the Eugene Island area.

Governor calls California gas rate meeting

Because he is " . . . increasingly concerned with sky-rocketing costs of natural gas to consumers in California," Gov. Edmund "Pat" Brown called a conference for June 21 to study the problem. Representatives from California gas companies; El Paso Natural, Transwestern Pipeline, Phillips Petroleum, etc., were invited to come to the session. California's "favorite son" presidential hopeful noted that El Paso, the "monopoly supplier" (*This company has a 'monopoly' on out-of-state gas only, operates in accordance with FPC regulations and certifications, and will no longer be the single out-of-state supplier when Transwestern starts deliveries in August. Ed.*) of natural gas to California, had increased rates 63 cents per Mcf in the past 16 months. He added that FPC hadn't even scheduled a hearing on the three El Paso boosts.

There is absolutely no blowing of gas to the atmosphere when you install a MUELLER® NO-BLO® Service Tee. Double pressure seal at top prevents leaks...

even at 1,200 p.s.i. working pressures!



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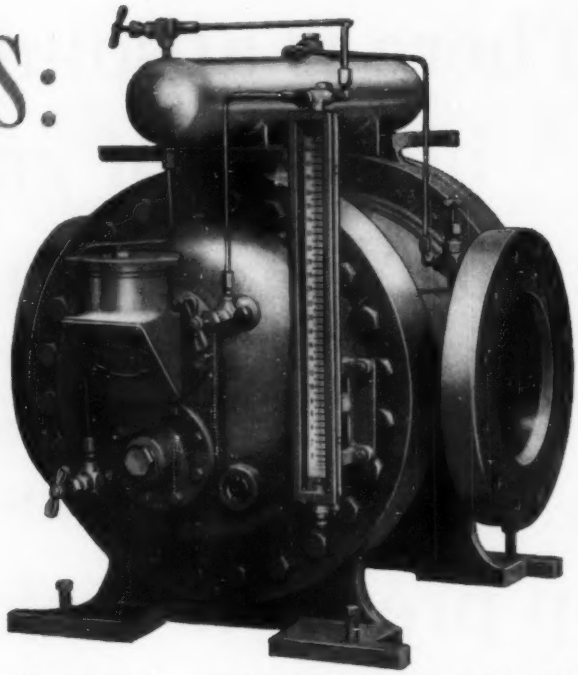

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A new line of 600 psig rotary positive displacement gas meters has been developed by Roots-Connersville to serve the needs of industries requiring extreme measurement accuracy in the higher pressure ranges. The meters are available in 4 sizes covering a range of from 84,000 to 1,600,000 scfh.

THIS NEW METER LINE IS IDEAL FOR MANY APPLICATIONS:

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- Well Head Measurements
- Steel Mills
- Underground Storage
- Metering of pulsating flow and surges, H2, 02, C02, NH3, LP gas, NO, He, C2H2, etc.

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The development of this new meter is another example of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.

Write us for additional information and data sheets about these new Roots-Connersville meters for 600 psig service.

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Regulatory and Legislative Trends

A COMMENTARY ON NATIONAL AND STATE DEVELOPMENTS BY AN EXPERT IN UTILITY LAW

California divides on accelerated tax depreciation

CALIFORNIA'S PUC divided 3 to 2 in its long-awaited policy decision concerning accelerated tax depreciation. For 45 days the staff took evidence on normalized versus actual taxes, plus comprehensive briefs by all utilities, numerous cities, and the government. Then the majority declared that "for the purposes of ratefixing, the Commission will not allow a public utility to charge to its operating expense for income taxes any amount in excess of the amount of income taxes lawfully assessed by the taxing authority and paid by said public utility."

• The dissents are convincing

Dissenting Commissioner Fox asserted:

"Insofar as 'normalization' of Federal income taxes is concerned, it must be pointed out that the entire rate-making procedure of this Commission involves 'normalization.' This is true not only in computing revenues but in estimating many expense items; therefore, it may be stated as a fact that 'normalization' is an accepted theory and principle that has been followed by this Commission for many years.

"By denying California utilities the right to normalize Federal income taxes for rate-making purposes, the Commission has denied the utilities of this state and the majority of ratepayers the advantages which, according to the records of Congress, Congress intended should accrue to such taxpaying corporations. In this regard, it is my opinion, despite the confusion generated by the voluminous and conflicting 'evidence' recorded in these proceedings, that the majority opinion is adverse to the public interest."

Commissioner Dooley in his dissent stated:

"In my opinion, it is adverse to the public interest to cause the utilities to refrain from using the liberalized depreciation provisions of the Internal Revenue Code. The internal funds that would be generated from the adoption of liberalized depreciation would reduce materially the large financing operations of utilities for expansion and replacement and, accordingly, would reduce their financial requirements and lower their cost of money and the resultant rate of return. This certainly would be to the advantage of the ratepayers and in the public interest. In any future rate-making proceedings involving utilities that elect to use liberalized depreciation and normalization of income taxes, the Commission, in computing the cost of money on that portion of the capital structure which is represented by the deferred tax reserve should then only allow a return equal to the difference between the average interest rate on a particular utility's long term debt and the return which is otherwise found to be normal. Such a procedure would have the effect of requiring the utility to pay interest on the deferred tax reserve. Thus, benefits would be made available to the ratepayers by reducing the utility's earning requirement, and at the same time allow the utility to participate in such savings as reasonable compensation for managing the properties, financed with funds provided through normalization, and for the resultant risk assumed."

There has been a national controversy over the treatment of accelerated tax depreciation in making rates for utilities. Millions of dollars are involved because the business is big. For an idea about size: assets of utilities, excluding transportation, amount to 20 per cent of the national total for all non-financial corporations. In a recent year, utilities sold $5.8 billions in securities which was half of all new corporate security issues. In a single year the revenues of utilities exceeded $21 billions. They are a huge segment of our national economy.

• California's majority opinion

Commissoners McKeage, Mitchell and Jenner joined in the majority opinion. It held that a public utility is not lawfully entitled to charge to operating expenses any income taxes in excess of the amount of such taxes which the Government lawfully assesses and which the utility pays.

A number of witnesses took the position that Section 167 of the Revenue Code provides for the deferment of tax liability which the taxpayer must respond to by the payment of higher taxes at some future date. Their position was that the tax differential which results from employing liberalized depreciation, as contrasted to straight-line depreciation, should be borne by present ratepayers by appropriate charges to operating expense just as though such amount had been paid by the utility. Such differential would be credited to a reserve for the payment of future income taxes. The procedure is called the "normalization" of income taxes for purpose of ratefixing. Other witnesses took the con-

Continued on page 128

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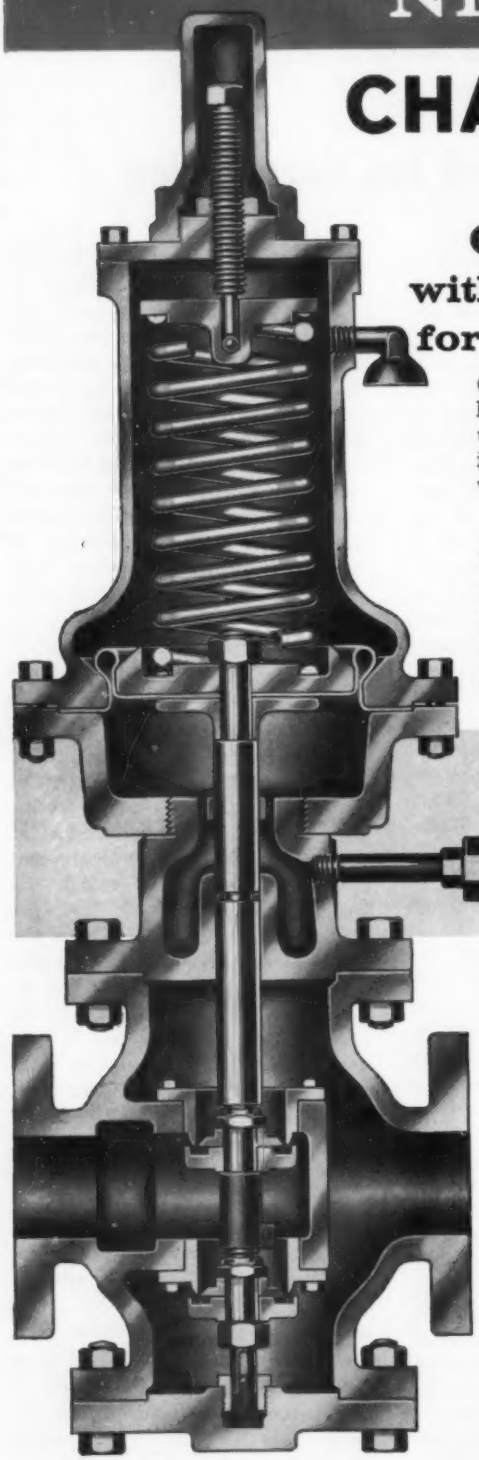

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Model 57-S

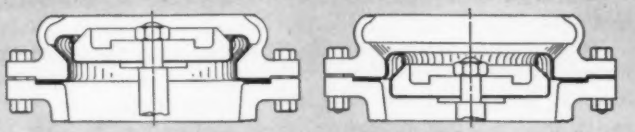
GAS REGULATOR
with "ROLL-OUT" Diaphragm
for constant pressure control

Chaplin-Fulton Model 57-S is a simple spring loaded regulator which performs like a pilot loaded regulator, without the added complications. For pounds-to-pounds service—inlet pressures to 400 psi—controlled pressures to 75 psi, with deviation through full valve travel less than 1 psi.

NO "FALL-OFF" AS FLOW INCREASES

The drooping characteristics or outlet pressure "fall-off", typical of conventional spring regulators, is eliminated—not by using an uncontrollable velocity effect—but by a new diaphragm design which actually reverses the action of a conventional diaphragm. It changes its area as the valve opens to compensate for the loss in spring loading force.

"ROLL-OUT" DIAPHRAGM PRINCIPLE



VALVE CLOSED VALVE OPEN

Note how, with the valve upwards in the closed position, the diaphragm achieves its maximum effective area—and decreases as the valve opens. The area changes at the same rate as the spring loses compression, to give a constant controlled pressure—determined entirely by valve movement.

2" - 3" - 4" - 6"
Write for Bulletin 57-S

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TECHNICAL TRENDS

By GUY CORFIELD

How near is competitive nuclear power?

There seems to be rather complete disagreement among experts as to when nuclear-fueled steam-electric generating plants may be expected to become truly competitive with conventional fuel fired plants. Some engineers say that such equalization is a long way off. Others assert that it is already here, in terms of known technology for large nuclear plants with high load factor in the higher cost fossil fuel areas. It seems rather sure that the day will arrive in the not too distant future.

The cost of a kwh at a conventional fuel fired plant is itself argumentative, but appears to be between 6 and 8 mills. Incidentally the electric industry has been asserting that with improved techniques and economies it has been able to hold the line on generating cost even in the face of rising fuel prices, while in the gas industry rates are progressively rising. Statements are now being made, however, that rock bottom has about been reached in steam electric efficiency and economy and rates must rise with any further increases in fuel costs.

The nuclear situation is no doubt changing rapidly as improvements are made and experience is gained. According to AGA's "Atomic Energy Highlights," a report by the Atomic Energy Commission last summer developed generating costs for nuclear plants of 150 megawatt capacity at from 11 to 18 mills per kwh; Bechtel Corp., however, has estimated that very large plants of 300 to 400 megawatts capacity, operating at very high load factor, and using design and construction economies that appear to be indicated might get down to between 7.6 and 6.5 mills per kwh.

Discussing the AEC's "10 Year Plan" for civilian reactor nuclear power, Chairman John A. McCone told the Congressional Joint Committee on Atomic Energy that the plan is aimed at economically competitive power in high cost fuel areas in the U. S. in 1968. McCone stated that to accomplish this, nuclear power would have to meet 7 mill per kwh power cost from conventional 300 megawatt power stations at 80 per cent load factor using fuel costing 35 cents per MMBtu.

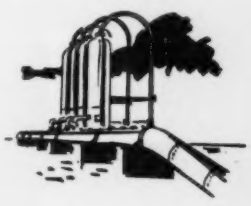
Several large plants are now operating, being built, or in the planning stage. As examples, Commonwealth Edison has just started its Dresden plant outside of Chicago; it is the first large plant to be privately financed (Commonwealth, and a group of other electrical utilities, and Bechtel Corp.); its capacity is 180 megawatts. Consolidated Edison Co. is commencing a plant at Indian Point, a few miles up the Hudson river from New York, which will generate 275 megawatts. On the West coast, Pacific Gas & Electric Co. is applying for permit to construct a 50 megawatt plant north of San Francisco, expected to be completed in 1962 and generate power at 8 mills per kwh. PG&E is apparently regarding this as somewhat of a pilot plant and thinking of a much larger one. President Sutherland is quoted by NUCLEONICS as stating that "nuclear power is an eventual must for the industry" and meanwhile the role of the utility is "to keep abreast of scientific and technical advances, to participate in such advances as far as possible."

The decision, for entry into nuclear power generation or extension of existing operations, seems to be hanging in the balance in many companies. Several, such as PG&E, are optimists, but "a NUCLEONICS survey of the presidents of 30 of the biggest electric generating companies turned up more pessimists than optimists on the nuclear power outlook."

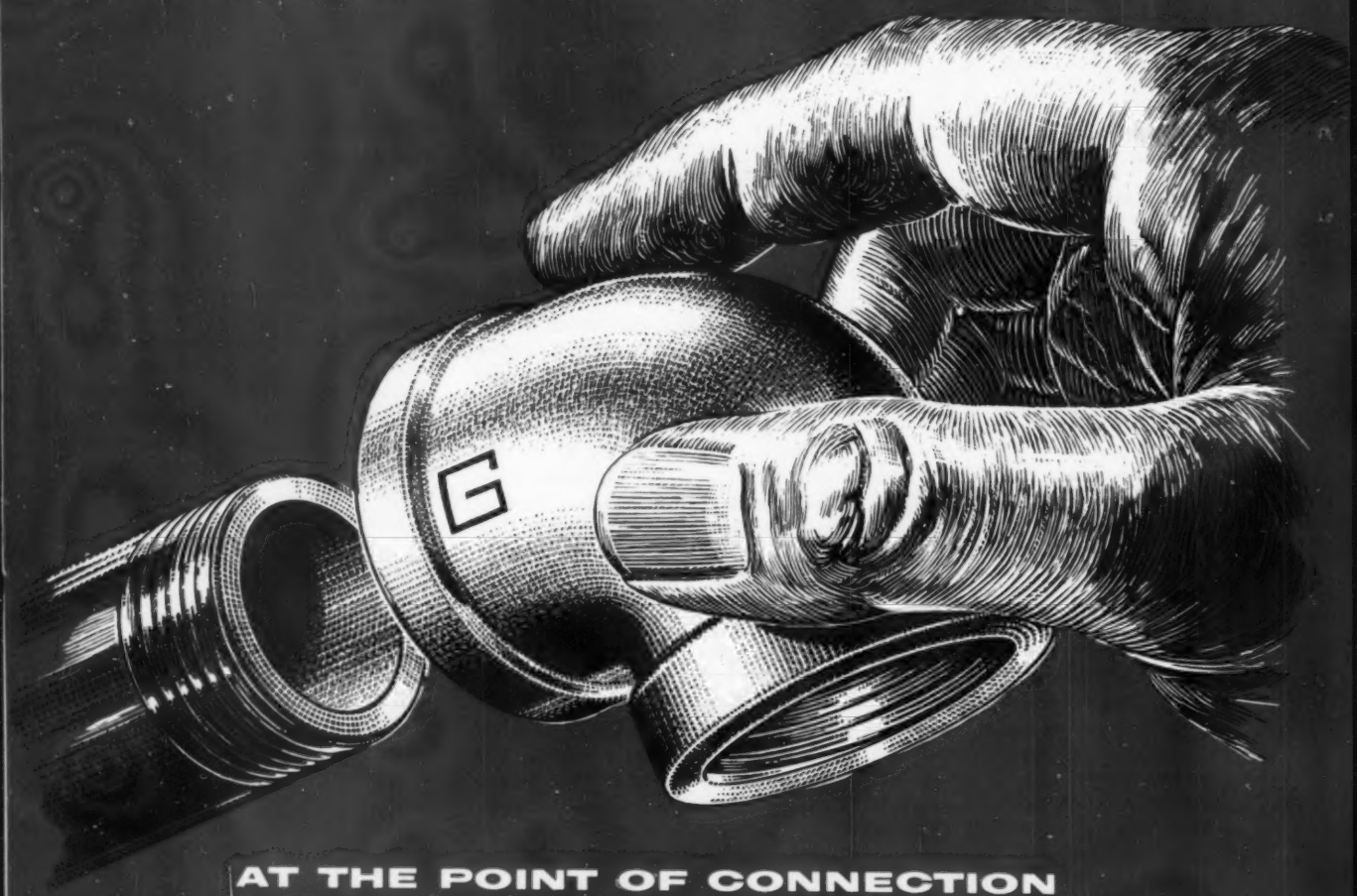
Negative ions for health

Negative ions — negatively charged atoms — in the air we breathe are said to reduce the discomforts of air-borne allergies such as hay fever, and also to promote a feeling of general well-being and comfort. While some natural phenomena such as radioactivity, cosmic rays and electrical atmospheric disturbances produce negative ions, they soon disappear in a normally heated or air conditioned room which humans occupy for extended periods.

If this beneficial effort is definitely established, it would appear that some means of generating negative ions in occupied spaces would be very beneficial, and might eventually be considered a normal requisite of air conditioning. Negative ions can be produced by applied radioactivity, by electrostatic devices and by materials at incandescent temperature. Philco has taken this matter seriously and has developed an Ionotron which is furnished with their "Super Power" air conditioner models, supplying negative ions to the fan-driven air stream. It is of the electrostatic type said to function as follows: The 115-v electric supply is raised to 4000 v and rectified to charge a fine nicrome wire which is the negative electrode. A steel ribbon parallel to the wire forms the positive electrode. The potential gradient produces positive particles and free electrons. The former are attracted to the wire, and the latter picked up by the air and discharged into the room as negative ions.



QUALITY



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WASHINGTON

By NEIL REGEIMBAL
GAS Washington Bureau

What's the record for this session?

CONGRESS leaves a steaming Washington this month for the heat of Presidential nominating conventions with little in the record to cheer gas executives.

As far as the industry is concerned directly, the lawmakers solved none of the problems of the industry, but managed to needle gas men with an investigation (see page 43) and take the first steps toward a possible national fuels policy.

In such vital areas as tax reduction or reform, natural gas legislation to bring some workable system to the federal government's gas control activities, or additional labor reform legislation, the lawmakers left a slate clean of any accomplishment.

At the same time, some of the proposals most sharply opposed by the industry, such as reduction of the depletion allowance, restrictive "safety" regulations for gas transmission and distribution, or expansion of government aid for municipal gas and electric utilities, also failed to pass.

For the long run, the most important congressional action this year to the gas industry was setting up studies which will undoubtedly in the future pave the way for a serious attempt to pass a so-called national fuels policy with end-use controls over gas.

Congress bowed to demands of the coal industry for federal help in its fight to regain lost markets by approving creation of a $2 million-a-year coal research program in the Interior Department. This program allegedly has no direct connection with the national fuels study proposal. It's set up on the surface only to give Uncle Sam money to help the coal industry study and develop better methods of producing, marketing, and using the black-lump fuel.

But many Washington observers believe that there's a good chance that this study will eventually turn to the competitive position of coal in relation to gas, oil, and electric power for various uses.

It is the industrial use of gas, particularly in off-peak seasons at demand rates, which the coal industry would try to block under the fuels policy proposal. Thus, the new Interior Department study and the fuels policy proposals are very likely to wind up running on the same track.

The lawmakers, at least until the final moments of the season, had balked at approving the actual fuels study proposal. Resolutions which would have created a special Senate-House committee to study the fuels policy question were blocked in both Senate and House, and appeared likely to remain there at adjournment.

This would mean they would have to be reintroduced again next year, when a new Congress and a new President would be in business.

But proponents in Congress didn't let the matter drop easily. The already established Senate-House Economic Committee picked up the ball and is now doing preliminary work leading to a study only slightly less ambitious than the coal industry wanted.

This group will use the congressional recess this summer and fall to conduct a study of the "rela-

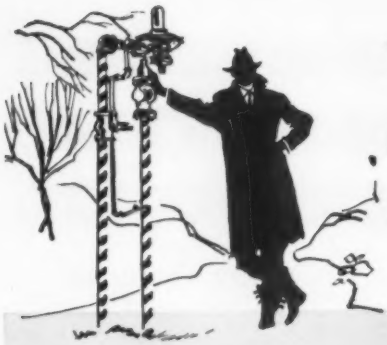
Continued on page 130

FPC has been dragged headlong into the coming election campaigns in more ways than one.

While the Harris Subcommittee was turning the commission into a campaign football for allegedly improper contacts between its members and gas industry officials, Democrats in the Senate were building another campaign issue. This was President Eisenhower's removal of Commissioner Connole and his choice of two men without regulatory experience as members.

The Administration's refusal to reappoint Commissioner Connole when his term expired will be a strong campaign issue in several sections of the country. Washington correspondents from the New England area and several midwestern states report considerable ill-feeling among vocal voter groups there over the Connole dismissal.

His successful labeling by some congressmen and publications as the "consumer's" commissioner somehow divorced him from the Harris probe in many minds, these correspondents report. The result, they say, is that there is a vague belief that the President fired the only "honest" commissioner — the only one not tainted with industry association, although he admitted as many talks with the industry as any of the others, and defended them as being proper.



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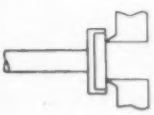
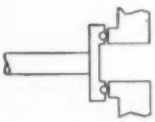
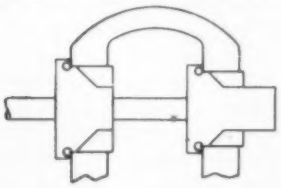
ORIFICE SIZES— INNER VALVE STYLES



⅛" Composition Disc Single Port. Max. Inlet 250 psi. 1¼" Composition Disc Single Port. Max. Inlet 150 psi.



⅛" "O" Ring Single Port. Max. Differential 250 psi. 1¼" "O" Ring Single Port. Max. Differential 250 psi. (with heavy main spring) 2" "O" Ring Single Port. Max. Differential 40 psi.



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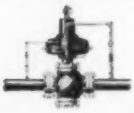

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SINCE 1880

Wanted: An invention

By MARSHALL E. PARKER

THERE is need in the field of soil corrosion and its control for an instrument which, so far as I can determine, is not presently available. What is needed is a rugged, reliable, accurate, sensitive, low-cost portable recording millivoltmeter. There are certain other requirements which the instrument should possess if it is to be optimally useful. None of these properties is chimerical; all are presently available in one instrument or another, but the combination does not exist.

Since this is to be a truly portable field instrument, it must be independent of power sources except for small internal batteries. The chart driving mechanism should be spring powered, and the instrument itself should be a transistorized vacuum tube voltmeter with a very high input impedance. Indicating instruments are available which satisfy these requirements, having input impedance as high as 300 megohms. Such an instrument, with multiple ranges from a low of 25 millivolts to as high as 100 volts would be quite useful. Even lower ranges—down to 1 millivolt full scale—would be highly desirable. But this would require a refinement of existing equipment beyond our self-imposed limitation of not asking for anything not already available. In one respect only, existing instruments would have to be improved: the zero drift would have to remain negligible for several hours.

The chart should be strip, rather than circular. The advantages are obvious, not the least of which is the ability to correlate two or more charts by aligning them. Also a strip chart provides a much more expanded ordinate or dependent variable scale. At least two chart speeds should be provided, one for prolonged 24-hr studies and one for the resolution of rapidly fluctuating variables. If the chart width is, say, 4 in., then the speeds might be 1 in. per hour and 12 in. per hour. A still slower speed could be useful if the drive could be powered for periods of a week or two; a still faster speed could be useful for the study of stray currents and transients.

It should be possible, without interfering with the operation of the recorder, to gain access to the chart for writing directly thereon, at or very near to the point where the record is being made (not at a point corresponding to the record made an hour ago). Since there is ample power available for driving the recording pen, the chart can be ordinary paper, and the pen a conventional type.

An improvement, though not a requirement, would be a true rectangular chart, instead of the usual curved ordinates. This feature does exist in some instruments, although they are all in the more expensive ranges at present.

What could be done with such an instrument? Its application in stray current studies would be no different from that of existing equipment. Its greater sensitivity, however, would open up some new fields of application. We could, for example, make a trip down a new pipeline, and install a half-dozen of these (remember, they were to be low-cost) at well-spaced test leads, connected between pipe and a copper sulfate electrode. The high input impedance makes this direct measurement of pipe-to-soil potential possible. As soon as we have established the set of recorders, we put into operation a test drainage point. First we drain a very low value of current—say 100 milliamperes—for 10 minutes. Then follows a 10-minute rest period. Next we drain a larger value of current for a similar period of time. This procedure is continued until we have used what we are sure is a sufficiently high value of current to protect the line, or at least one high enough to enable us to extrapolate to protection.

Then we pick up our gear, making one more trip down the line to pick up all our recorders. This procedure will furnish us with a good complete current requirement test on our pipeline. Even in the face of fairly severe fluctuating potentials, we shall still have a valid value of polarization potential (difference between "static" and "off" potentials) because the two are taken in rapid succession. And it should not take many such tests to save enough travel time—one round trip as against at least two—to pay for the recorders.

Interference studies? Set up a group of the instruments at selected points, some recording pipe-to-soil potential, others potential between structures, others bond currents (by using shunts), and then vary the currents at all of the rectifiers which may be causing trouble. If a time log is kept of these variations, an analysis of the charts should give as much data as could be gathered in a couple of weeks of the usual type of interference investigation.

The two applications cited above are just a beginning. An instrument as described, simple to use, rugged enough to require little maintenance, and with a well-chosen set of scales and accessories, would be applicable to the solution of a large number of the corrosion engineer's daily problems. Can anybody offer us one soon? ■

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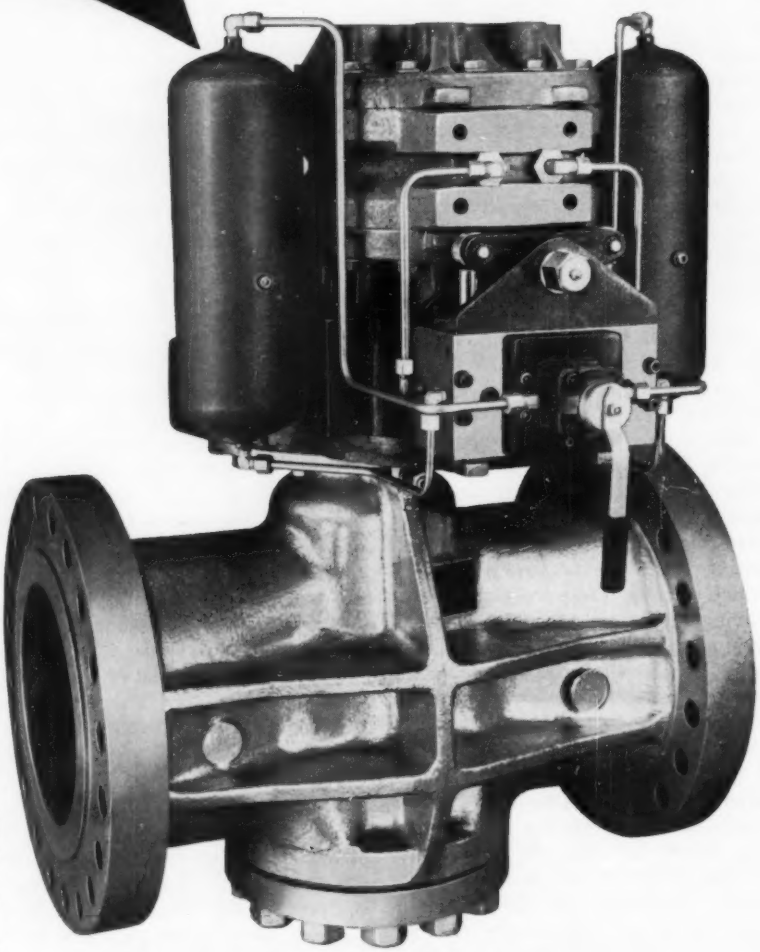

These operators have oscillating vane type Hydraulic motors, applying power directly to the plug valve stem—they can be mounted in any position, and are designed to eliminate the usual gearing found on plug valves.

The new LimiTorque type "G" operators are designed primarily for utilization of gas pressure from the pipe line on which they are installed; however, they can be operated by air or liquids from other pressure sources —with or without accumulators.

For pressure operation, the units are equipped with a shear-seal type directional control valve having three positions: Valve open, valve closed, and neutral. For manual operation, the units operate through a specially designed hand pump mounted on the side of the vane motor. The type "G" units can be easily mounted on the plug valve, and because they are directly centered over the shaft . . . It is not necessary to remove the valve from service in order to install the type "G" unit. No maintenance is required with these operators, and it is not necessary to check the level of oil in the accumulation tanks, as this is taken care of automatically.

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To bring the philosophy and problems of the natural gas producer to you, GAS reached deep into the Gulf Coast area and happily "signed up" James A. Clark, dean of the gas and oil writers of the Southwest. For more than 30 years, Jim Clark has been in, around and on top of both the natural gas and oil industries. He has seen the gas business bud off from the oil game and grow into full bloom. From Houston then, each month, he will bring GAS readers his personal impressions and interpretations.

Jim Clark has written such books as "Spindletop" (the story of an oil field that changed the world); "Three Stars For the Colonel" (biography of Gen. E. O. Thompson); and "The Tactful Texan" (biography of Gov. W. P. Hobby); all published by Random House.

He currently has his own company (oil and gas consulting, and writing) and syndicates two weekly oil and gas columns to newspapers in many sections of the country.

So here, then, is an introduction to:

The gassing game

By JIM CLARK, Houston, Texas

NO more remarkable change has ever been made in any industry in so short a time as that made in the natural gas producing industry since the end of the Second World War.

As a new columnist for GAS I feel that I should have the liberty of explaining my connection with the business and the change I have seen in Texas and Louisiana, particularly.

In 1939 I was oil editor for the Scripps-Howard Houston Press. One day I stepped into the office of Glenn McCarthy, the famous wildcatter, who was then just in the process of undergoing his first of several financial crises, and asked about a new gas distribution company he was building in my home town, Beaumont, Texas.

By way of opening the conversation I mentioned to McCarthy that he really should hire me to run the company, not because I knew anything about the gas business, but because I knew Beaumont.

At that point he put me under a momentary scrutiny of those steel eyes for which he was so noted in his oil deals. Then he picked up the telephone and dialed the number of Williams Brothers Corporation and got the late Joe Horrigan on the telephone.

"Joe," he said, still glaring at me as if I were some kind of puzzling object, "I have the man to manage that Beaumont company."

When I realized he meant me I was shocked. But when he said, without asking what I was making, that he would double my salary if I would start working in a week, I began to think of ways I could get out of the job at the Press. I solved that one by training a news desk man in oil writing in a fast five or six-day cram course in the subject. Incidentally, he later became a successful oil operator.

Anyway, I went to Beaumont to "compete" with the United Gas Corp. For United it wasn't very fair competition. We had a gas field on the outskirts of Beaumont. United refused to give McCarthy the kind of contract he wanted to sell the gas, so he obtained a second franchise in the city. We sold gas to consumers in all classifications in Beaumont at from one third to one half of United's existing rate.

Of course, I knew about as much about running a gas distributing company as a mule knows about a holiday. That was the only real bright spot in United's predicament at the time. And World War II stole that advantage from United when I went into the service.

But what this goes to show is how unstable the natural gas business was in the Texas Gulf Coast in the late thirties. We were selling industrial and even some commercial gas on five-year contracts for 10 cents a thousand. The gas cost us nothing since it was just sitting in the West Beaumont field without a market. The field was actually partly within the city limits. It was our price that forced the city to grant the unusual second franchise.

The real advantage to McCarthy was the fact that he could get all of the liquids that came up with the gas without proration. And the gas was rich in condensate, which had more value than the highly prorated crude oil from the same field.

About that same time McCarthy made contracts with Dow Chemical for gas from a field in Brazoria county for as little as a cent or two a thousand. Dow built the line from its Freeport plant and picked up the gas at the field. Other contracts almost as ridiculous were made with many other industries along the coast.

But in those days natural gas was Texas' sleeping giant. It was virtually untapped for industrial purposes. It was a drug on the market that was being flared from thousands of fields all over the state by the billions of cubic feet daily.

The state had a law that enabled an operator to produce all of the liquids he could get out of gas for any market he might have. It was a first attempt to stop the flagrant waste that was going on. The law, which still exists, is now under study in Texas, incidentally, with a view toward prorating gas liquids.

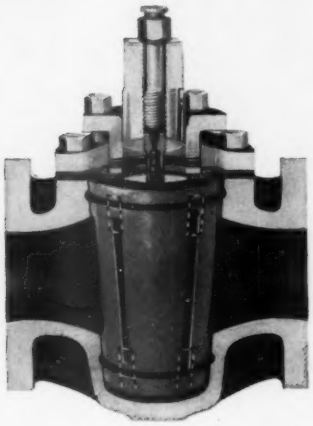
Continued on page 134

the idea:

Simplicity Is Basic To Efficiency and Economy

One of the world's first valves, plug cocks invented by the Chinese centuries ago, had only one moving part—the plug. Even the earliest craftsman recognized the fact that simplicity of design almost always means a device that works better, lasts longer and costs less to use.

the application:



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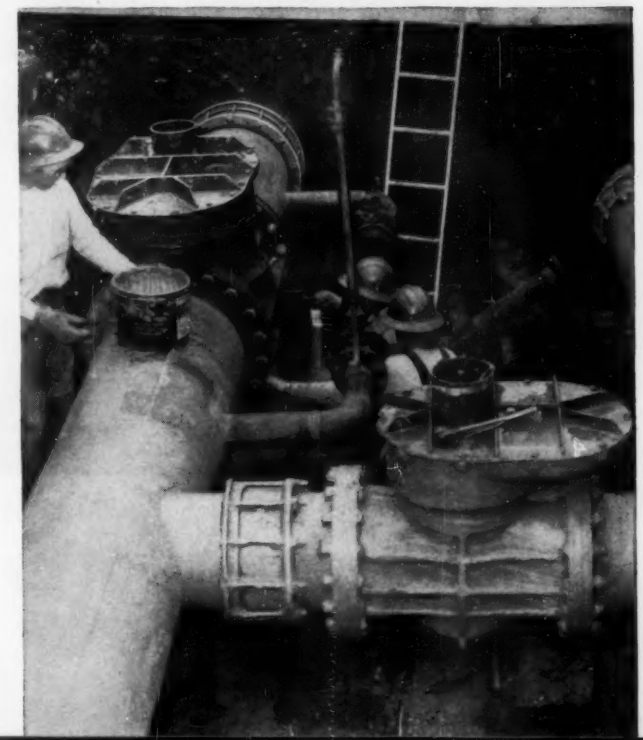

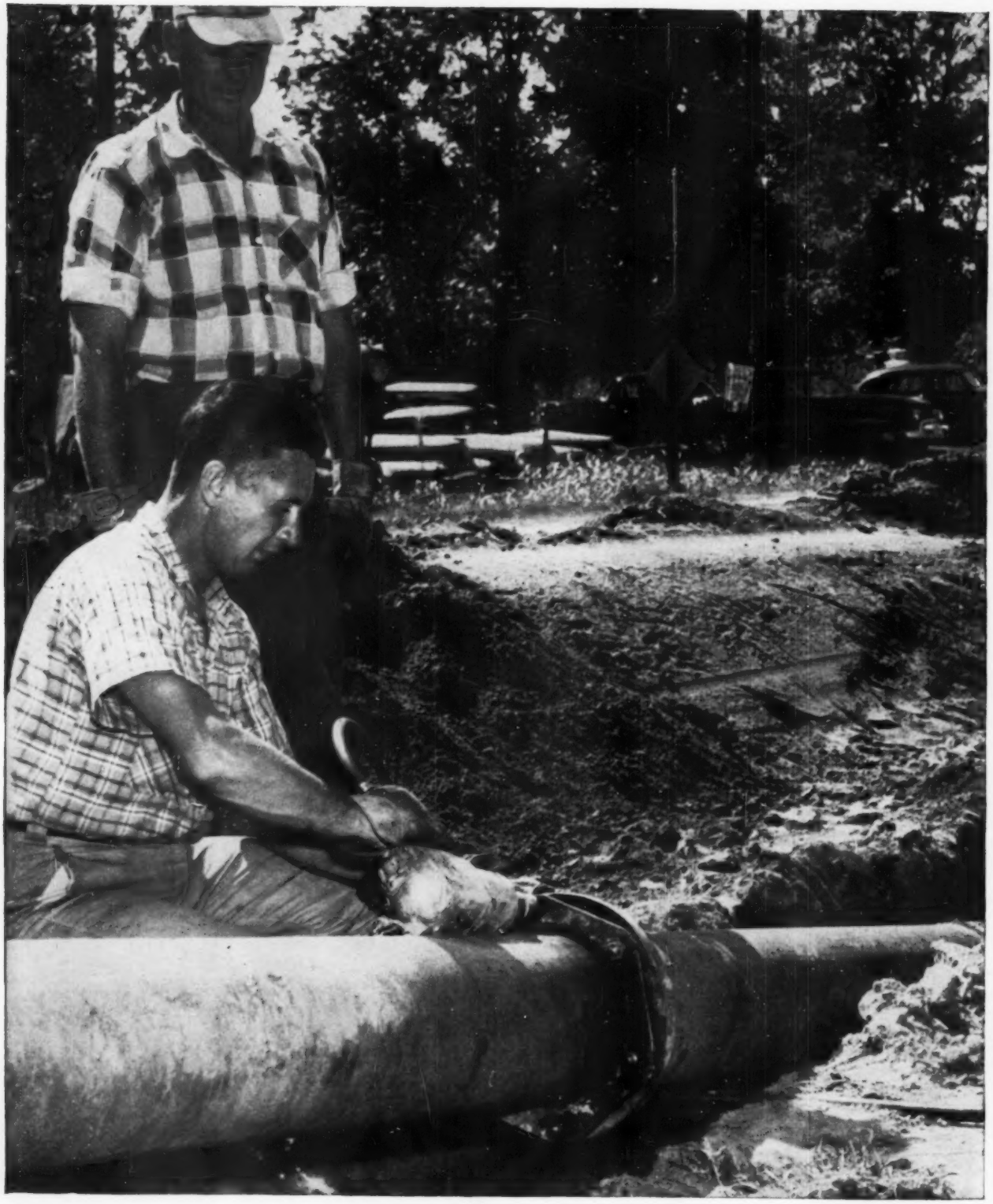

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6323

CAP FORGED STEEL

INSULATING UNION

GREATER SAFETY • FEWER REPLACEMENTS

ENGINEERED—TESTED—PERFORMANCE-PROVED

for gas service

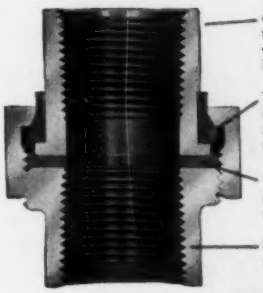
Each year, more corrosion engineers specify CAP Insulating Unions for their meter installations. These are necessary to assure maximum service from pipe and equipment. Insulating unions prevent corrosion caused by electrolysis.

Both the Capitol *Special* and *High Temperature* insulating unions are engineered specifically for gas service—performance-proved by years of service without a single failure—tested for assured quality control.

The *Special* insulating union is recommended for normal applications and will withstand up to 250° F (external heat). The *High Temperature* insulating union will withstand 450° F for one hour (the temperature at which solder in the meter will melt). The *High Temperature* union is designed for maximum protection against a gas leak in the event of a fire.

Only CAP gas service insulating unions have all of these features:

- Forged Steel construction—eliminates danger of sand holes or porosity.
- Exclusive Heavy Tapered Insulation—make connections 3-times stronger than light square type.
- Color Coded—for easy identification by service crews . . . orange for *Special* . . . yellow for *High Temperature*.
- Black oxide coated to prevent rusting.
- Two-thirds insulating unions, *Special* and *High Temperature* are available.


ALL FORGED STEEL for maximum tensile strength — no porosity — no sand holes.
TAPERED INSULATION assures 3-times stronger connections than light square type.
INSULATING is tested and proved effective, long-lasting.
NATIONAL PIPE TAPER for tighter joints.

Add to the life of your company's piping and meters by using CAP Insulating Unions on all installations.

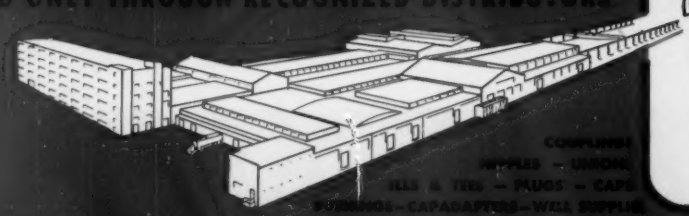
CAP *Special* and *High Temperature* Insulating Unions

Size	Overall Dimensions	Special Part No.	High Temp. Part No.	Quantity in Carton	Approx. wt. per 100
¾″	2.27″	GS-33	GHT-3	20	72#
1″	2.89″	GS-44	GHT-4	12	110#
1¼″	2.96″	GS-55	GHT-5	10	150#
1½″	3.07″	GS-66	GHT-6	5	220#
2″	3.48″	GS-77	GHT-7	5	340#

CARTONED:

Packaged in small cartons for easier handling, better protection, save time and reduce inventory losses.

SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS

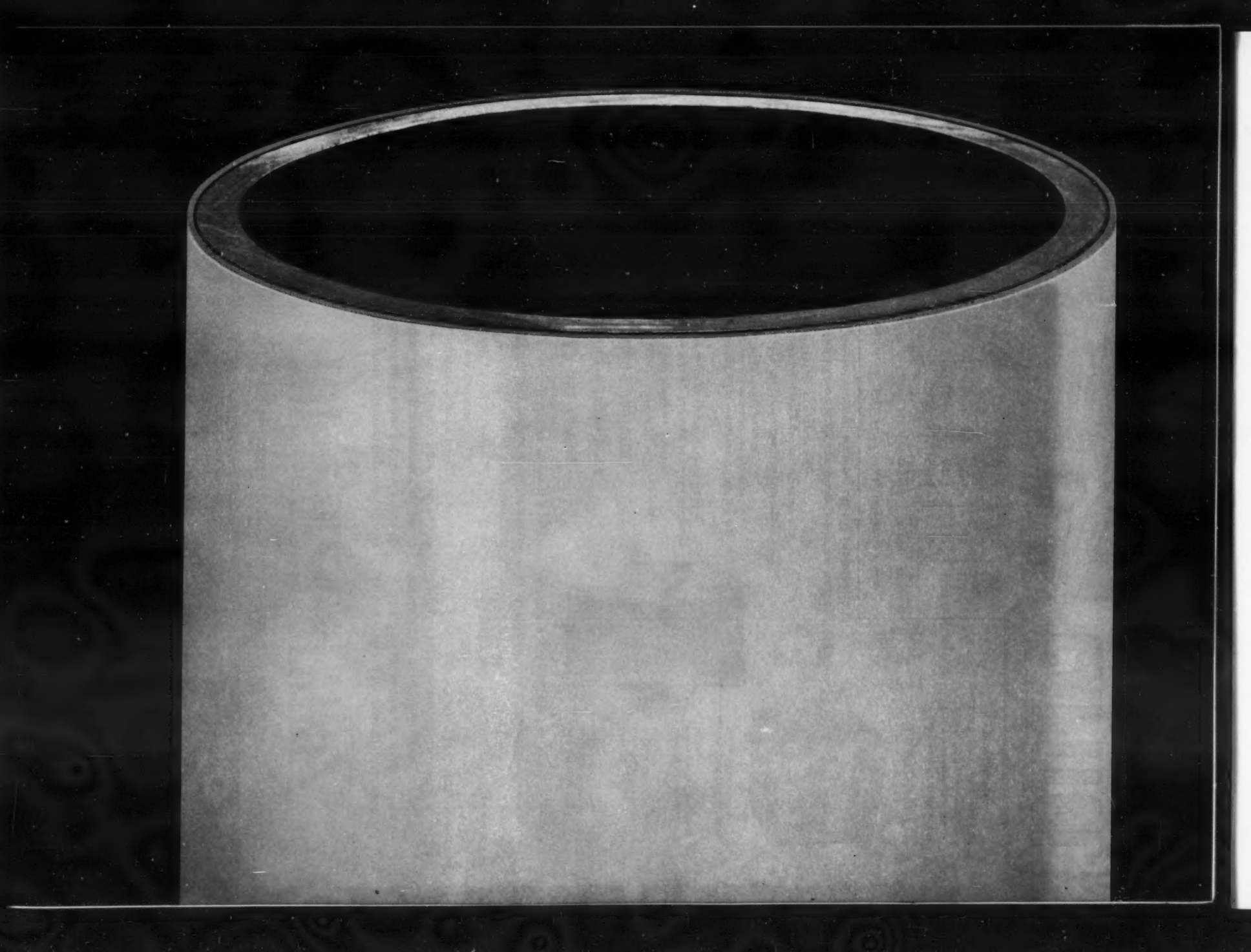


CAP CAPITOL

MANUFACTURING CO.

DIVISION OF HARSCO CORP.

COLUMBUS, OHIO



6" AND 8" X-TRU-COAT IS HERE!

PROVEN CORROSION-PROTECTION for more and bigger piping jobs comes with Republic's announcement of new 6⅝" and 8⅝" O.D. X-TRU-COAT. The new sizes bring the size range from 1.050" through 8.625" O.D. (Already our customers are suggesting that we think about producing even larger sizes. And the customer is always right.)

The ability of Republic X-TRU-COAT to stop chemical and electrolytic corrosion has been proved in hundreds of installations. The same installations have demonstrated that X-TRU-COAT's rugged plastic coating is resistant to shipping, stringing, and backfilling damage.

X-TRU-COAT's high-density polyethylene plastic is continuously extruded over "live," pressure-sensitive undercoating. This undercoat never becomes hard or brittle. It eliminates the threat of underfilm migration.

Republic also offers new X-TRU-TAPE Polyethylene Joint Wrap (in 1-, 2-, and 4-inch widths) and X-TRU-PRIMER. Both assure maximum and homogeneous joint protection for the entire pipeline. For information or quotations on the complete X-TRU-COAT package, call your nearest Republic representative or mail the coupon below.

Republic X-TRU-COAT is produced under the Dekoron® Process.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
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1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on X-TRU-COAT

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

MULTI-FUNCTION WILCOLATOR CONTROL

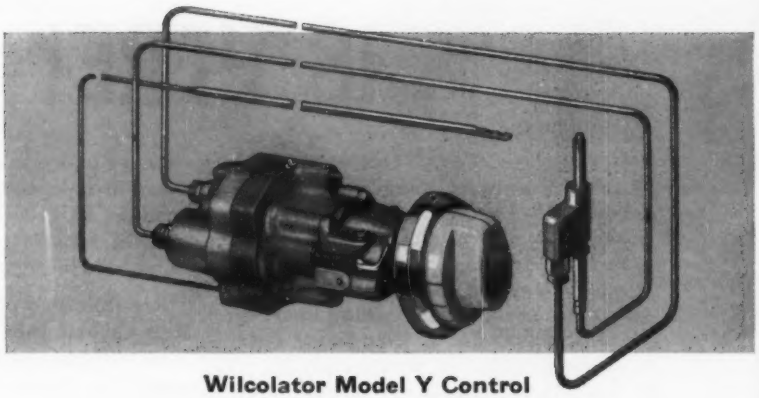
is 4 ways better

1 Lower installed cost

2 Positive safety shutoff

3 Smaller, more compact

4 Simple construction, easier to service



Wilcolator Model Y Control

Temperature range:
200-500°F, plus broil

AGA rating, Btu/hr:
Manufactured gas—43,045
Natural gas—63,700
LP gas—136,000

The Wilcolator Model Y thermostat is a high-capacity unit delivering top efficiency as a gas valve, automatic pilot, oven temperature control, and pilot filter. Its advantages (shown above) add up to dollars-and-cents savings.

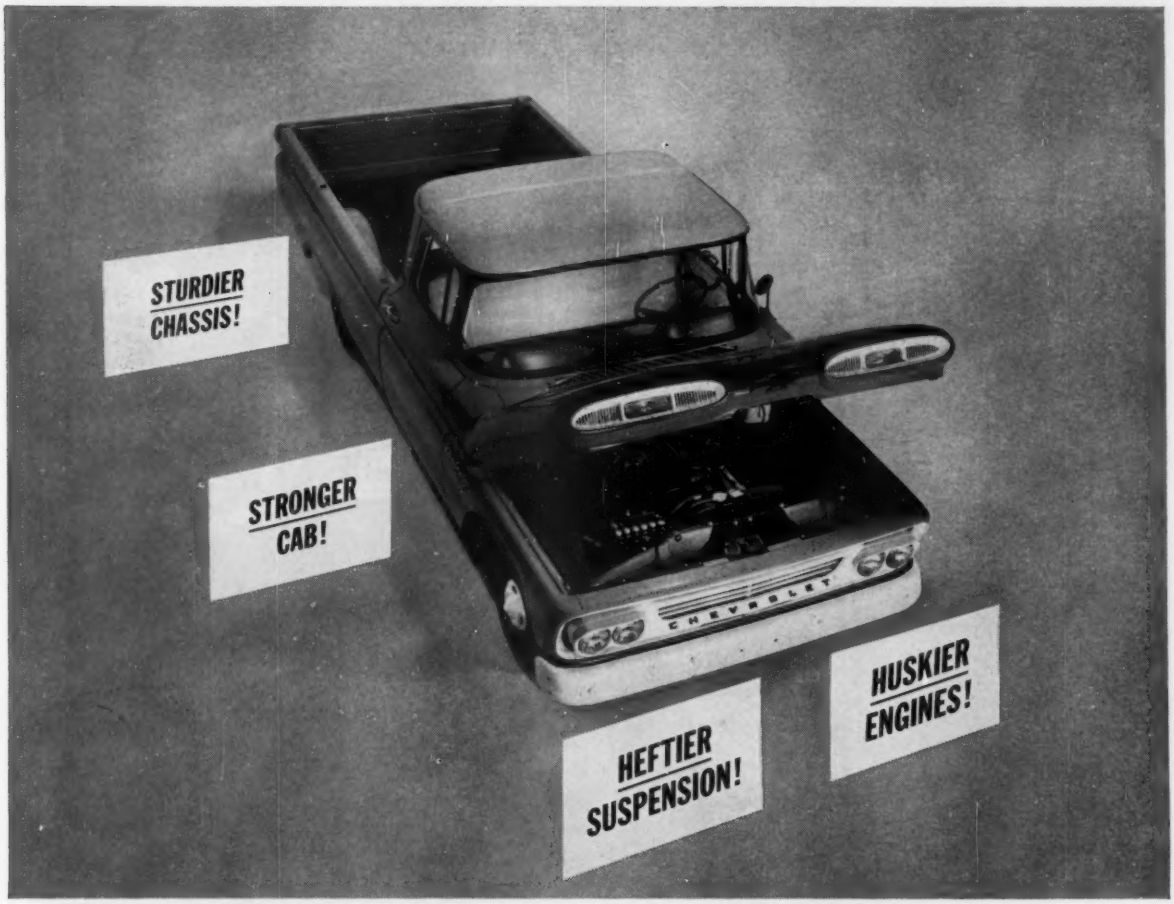
The Model Y is designed to be installed quickly and easily on any gas range . . . with a minimum number of fittings. At the same time, it is extremely easy to service because of its simplified construction and the fact that adjustments can be made from the front of the range. It is also available with filtered top burner pilot takeoff which eliminates a separate pilot filter. Throughout, the Model Y reflects the benefits of Wilcolator's 35 years' experience in the thermostatic control field. It is described in detail in Wilcolator's Bulletin 568 — copies are yours for the asking.

Thermostats for Every Heating and Cooling Application

THE Wilcolator COMPANY

THE WILCOLATOR COMPANY
1001 NEWARK AVE., ELIZABETH, N. J.

In Canada: Wilcolator (Canada) Ltd.
221 Evans Ave., Toronto 18, Ont.



CHEVY'S PUT TOGETHER TO STAY TOGETHER ...TO CLAMP DOWN ON COSTS!

Here are the strongest truck components known ... assembled lastingly, with care and craftsmanship. It's Chevy's way of making sure you get maximum truck life; extra assurance of higher profits because of far fewer maintenance and repair charges.

NEW STRONGER CAB CONSTRUCTION. New steel braces reinforce cab underbody, help keep cab tight and solid. Husky new box-section pillars frame door openings, keep doors in lasting alignment. New roof panel is double walled for extra strength.

NEW STURDIER CHASSIS COMPONENTS. New stronger *frames* with rigid box-section rail design increase torsional stiffness up to 1100%! And *brakes* are bigger for longer brake life and safer stopping. Bigger capacity *axles* and *suspensions* boost load-carrying ability.

TRUCK-BUILT V8's AND 6's. Components such as brawny forged steel crankshafts, long-lasting precision bearings and oil bath air cleaners provide sure dependability that keeps your maintenance costs *down*.

NEW HEFTIER SUSPENSION smooths the ride; protects everything from wear and tear. Independently suspended front wheels, rigid control arms and strong torsion bar springs take tough runs with strength to spare.

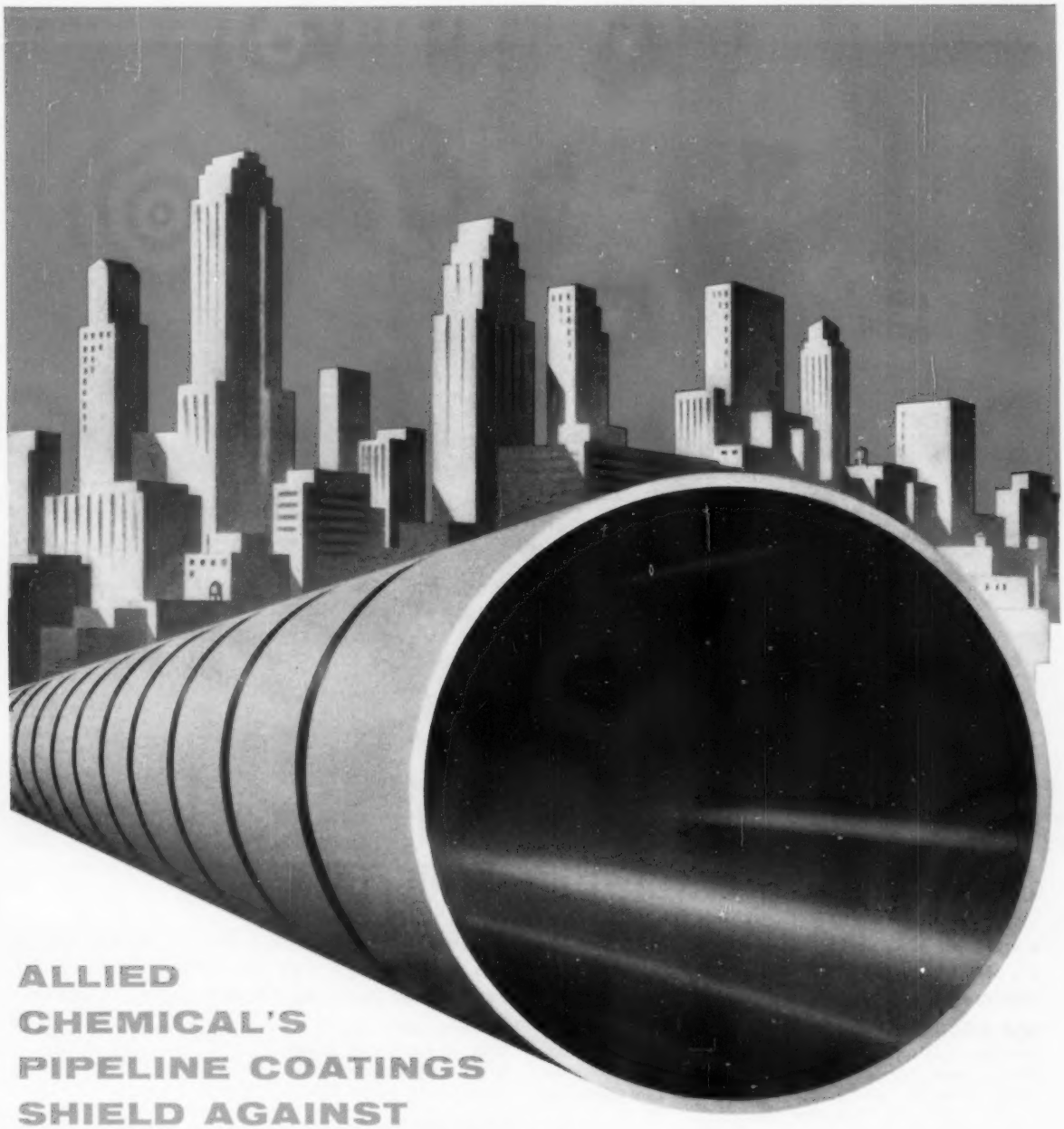
■ Chevrolet's building 'em *tough* these days, even tougher than ever before. And that's saying something when you consider how Chevrolet trucks have stood up over the years. Here's a typical example:

101,000 miles on a truck-busting job—and still going strong! The strength and stamina of this Chevy pickup has paid off handsomely for the Mitchell Insecticide Company, Inc., of Fairfax, S.C. In rugged service, hauling maximum loads of nitrogen throughout the southeastern states, this Chevy has logged 101,000 miles with no mechanical trouble at all.

That kind of performance has been Chevy's stock-in-trade for years; and the '60's are designed to put out even more of it. See your dealer for all the details. . . . Chevrolet Division of General Motors, Detroit 2, Mich.

1960 CHEVROLET STURDI-BILT TRUCKS

CHEVROLET



ALLIED CHEMICAL'S PIPELINE COATINGS SHIELD AGAINST CORROSIVE ELEMENTS!

Corrosion is costly. The protective coating materials of Allied Chemical offer time-tested protection against the forces of corrosion which eats away at pipeline investments. Proved and improved for three generations — our durable Pipeline Primers, Enamels, and Auxiliary Protective Pipeline Felts — form a maximum barrier against corrosive elements. Get the most dependable coating combination for your next pipeline job. Write to us for full information.

Though we've changed the name from Barrett to Allied Chemical Protective Coatings, you receive the same famous protection in pipeline coatings —proved and improved for three generations.

PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

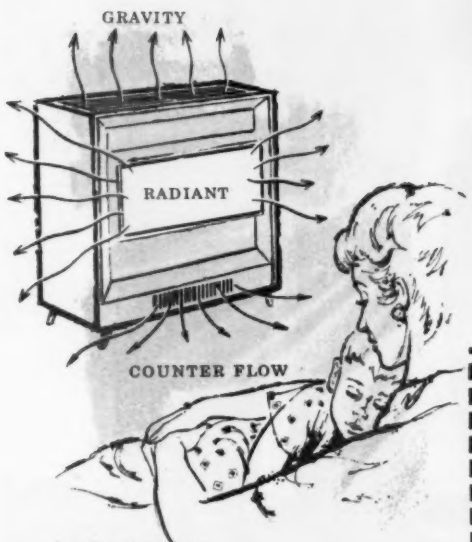
Allied Chemical

no burner will ignite or extinguish as quiet as...

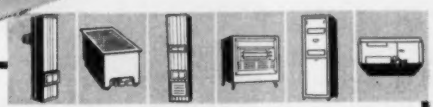
EMPIRE RADIANT IMPERIAL

The new Empire RADIANT Imperial Room Heater *now* has more sales-appeal outside and more superior features inside...

• Automatic temperature control • Special no-noise burner • Lint Free Burner • Powerful 4-speed blower...and many other features that guarantee MORE Sales and MORE Profit.



the cheeriness of an open fire-place... the efficiency of a MODERN GAS HEATER.



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Manufacturers of the finest complete line of Certified Gas heating appliances

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Quick! Send more details on the RADIANT Imperial.

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DEALER NAME _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

MEMBER NATIONAL LP GAS COUNCIL

advance the gas flame everywhere

MUELLER® NO-BLO®
LINE STOPPER FITTINGS

...to match any need!

■ Whatever your need, there's a Mueller quality-built No-Blo Line Stopper Fitting to fit it *exactly*. Sizes from ¾" to 12" . . . welded or mechanical joints . . . for steel, thin-wall steel or cast-iron pipe . . . with pressure ratings from 125 to 1,200 p.s.i.

Write for information on fittings you require.

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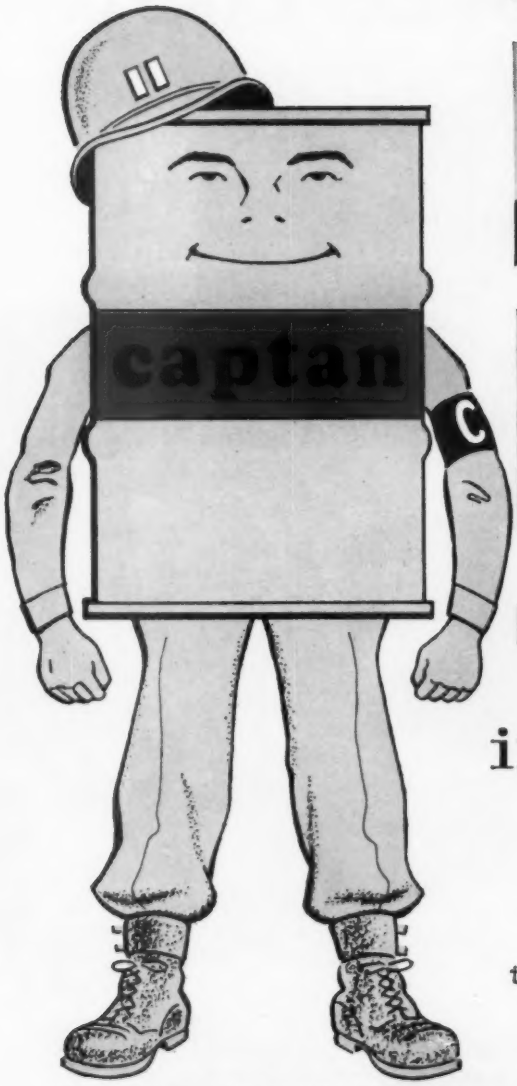
MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited; Sarnia, Ontario



CAPTAN OF THE GUARD

Al King
Western Canada

Walt Fitzgerald
North East

Chauncey Robinson
N. C. & E. Canada

Maurice Calaway
Far West

Charlie Hall
Mid West

John Worth
South East

Irvin Peffley
South West

Howard Dickerson
Plant

Seth Roberson
Home Office

The Most
in experience . . .

A Profile of the CAPTAN of the GUARD

He deals exclusively in gas odorants, is an expert who is available for consultation or service at all times and is an odorization equipment troubleshooter.

He had 55 years in the gas utility field before entering the odorant business and has a total of 79 years in gas odorization.

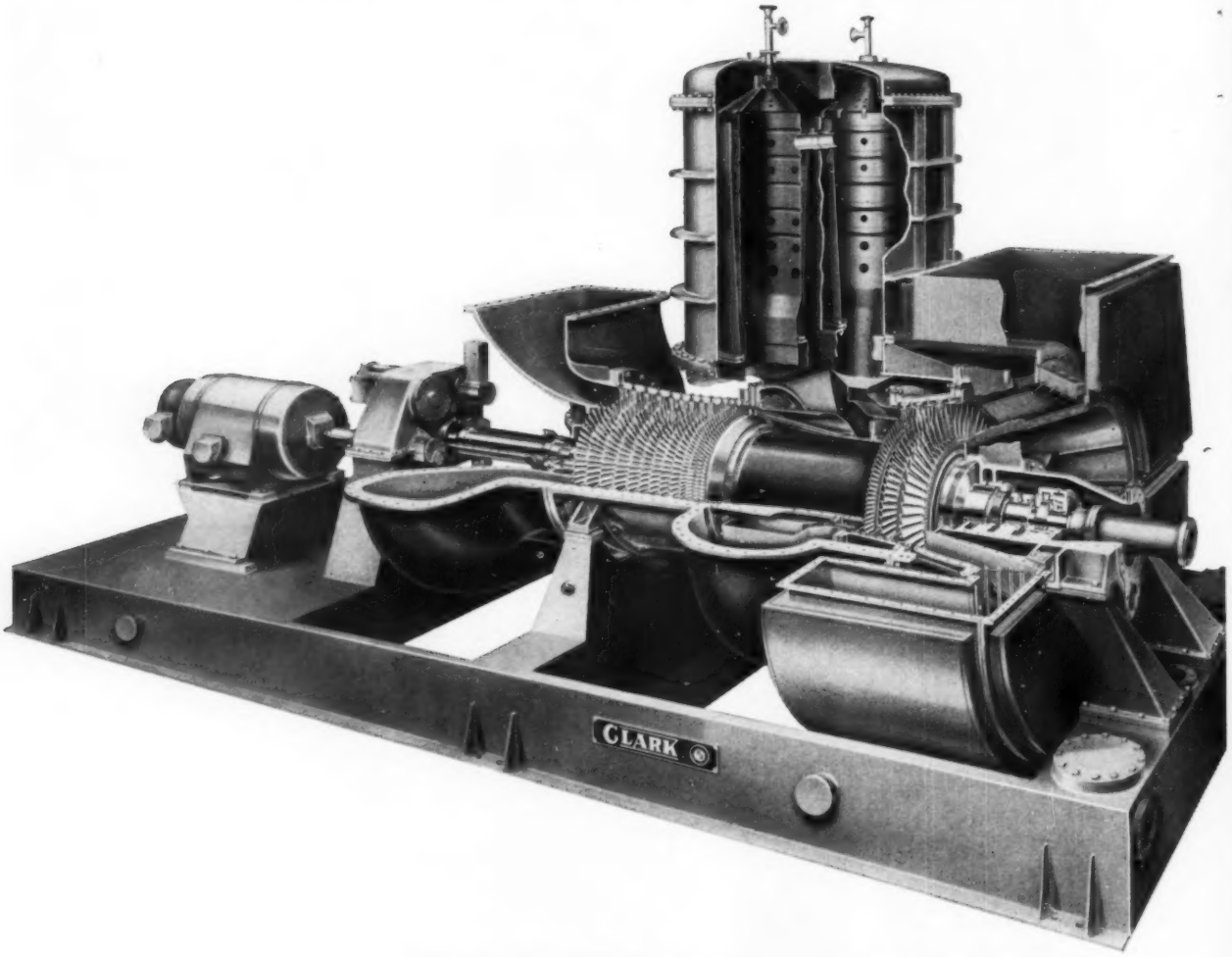
He is in constant contact with the gas utility industry through the more than twenty-eight hundred calls he makes each year.

☆ ***Don't delay . . . phone, wire or write us today!***

NATURAL GAS ODORIZING, INC.

60-3 P.O. BOX 15252 • HOUSTON 20, TEXAS

No matter how you gauge PRIME MOVER COST...



CLARK BROS. CO., OLEAN, N.Y.

CLARK®

DRESSER INDUSTRIES INC.
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

ENGINES • GAS TURBINES • COMPRESSORS

the CLARK 300 series of GAS TURBINES measures up fully to your needs

Name the norm . . . capital investment, floor space, installation or operating labor, general reliability, maintenance or all combined. Whatever you use to determine *real* prime mover cost, Clark heavy duty industrial gas turbines provide the most economical answer to your requirements. As an example of how these advantages work for you let us examine the latest addition to the Clark 300 series of turbines, the Model 305-S.

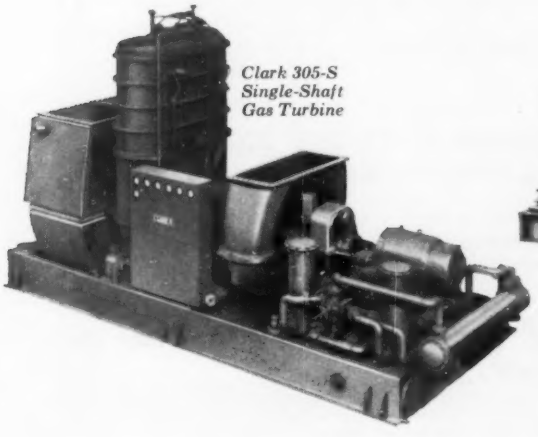
CONSIDER INITIAL INVESTMENT—This single-shaft open cycle machine is simplicity itself. With the axial compressor and three stage turbine mounted on the same shaft, parts . . . *and cost* are cut to a minimum.

FIELD PROVED RELIABILITY—Important components such as compressor and turbine blading are based on proved designs which have operated for thousands of hours in Clark Dual-Shaft Gas Turbines. Turbine inlet temperature is held under 1400° F to ensure extra long life and to provide a substantial margin of operating safety. The turbine is completely air cooled and suitable for operation in arid country. Pressurized air is bled off the axial compressor to cool turbine blade roots and other high temperature components. In addition, cool air envelopes between inner and outer skin surfaces reduce heat loss and minimize heat radiation.

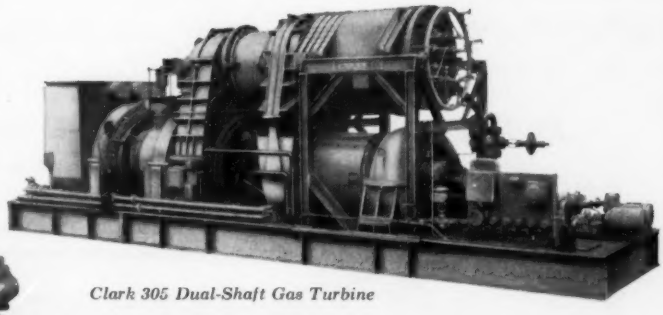
FLOOR SPACE INSTALLATION AND MAINTENANCE—The Clark 305-S is so compact it is mounted on a skid only 26 feet long. The combustion chamber with two parallel burners is placed over the rotor between compressor and turbine. You save on floor space, housing, transportation to the site, foundation and installation expense. Both the single and dual-shaft Clark gas turbine designs have provisions for easy access to blading, bearings and seals for inspection or maintenance.

VERSATILE TOO—Clark Series 300 Gas Turbines in the 8000-10,000 horsepower class provide the inherent flexibility to match the application. The dual-shaft models are excellent drivers for pumps or compressors on liquid or gas transmission lines, for marine propulsion, compressor drivers in repressuring or process plants and other uses requiring broad speed and loading flexibility. For applications that do not require the wide range flexibility of the dual-shaft machine such as base load or peaking turbogenerators the single-shaft units are ideal. Both designs burn either liquid or gaseous fuels.

Your Clark representative will gladly give you all of the cost saving details on Clark Gas Turbines. Consult him or write us direct. CLARK BROS. CO., OLEAN, NEW YORK.

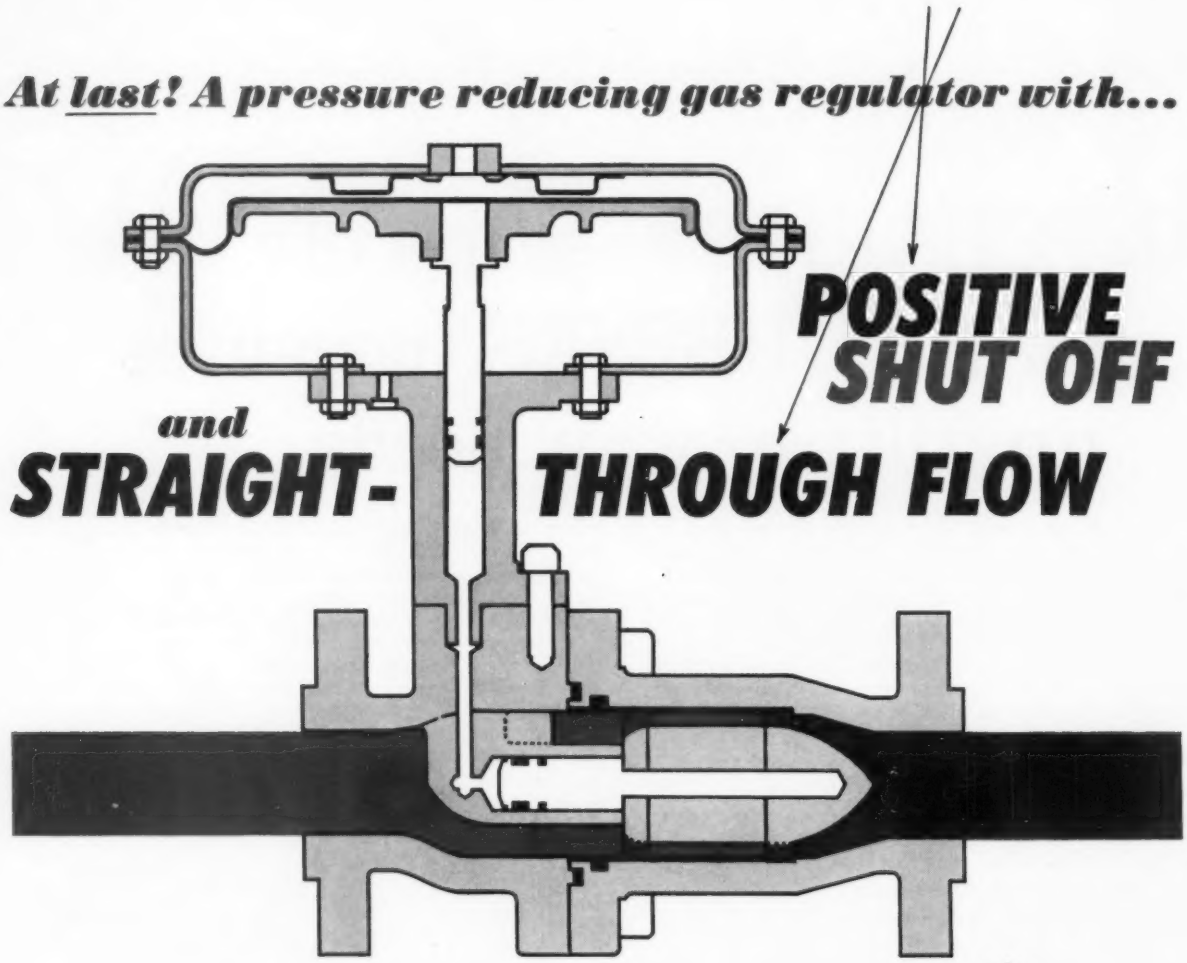


Clark 305-S Single-Shaft Gas Turbine



Clark 305 Dual-Shaft Gas Turbine

At last! A pressure reducing gas regulator with...



POSITIVE SHUT OFF

and

STRAIGHT-THROUGH FLOW

The NEW Jet Stream Regulator *

Now you can stop high-speed gas turbulence, sound vibration, and leakage in your pressure regulators. The Jet Stream Regulator gives you straight-through laminar flow, positive shutoff, and no mechanical friction. Jet Stream's laminar flow stops the jetting of high speed gas and transient particles. This smooth straight-through flow also reduces sound vibration. Jet Stream's hydraulically actuated slave piston regulates flows with extremely fine control . . . from full flow to bubble-tight shutoff in three seconds. For efficiency and safety in your pressure reducing gas regulators . . . *use a Jet Stream Regulator!*

* *manufactured under the Welker Patent*

THE JET STREAM REGULATOR IS MADE IN THREE MODELS
• FLANGED • THREADED • INSERT

Write for the Jet Stream Catalog. A catalog giving complete specifications on the Jet Stream Regulator is available upon request.

APCO **DIVISION OF TEXTRON INC.**

engineering • design • development • manufacturing

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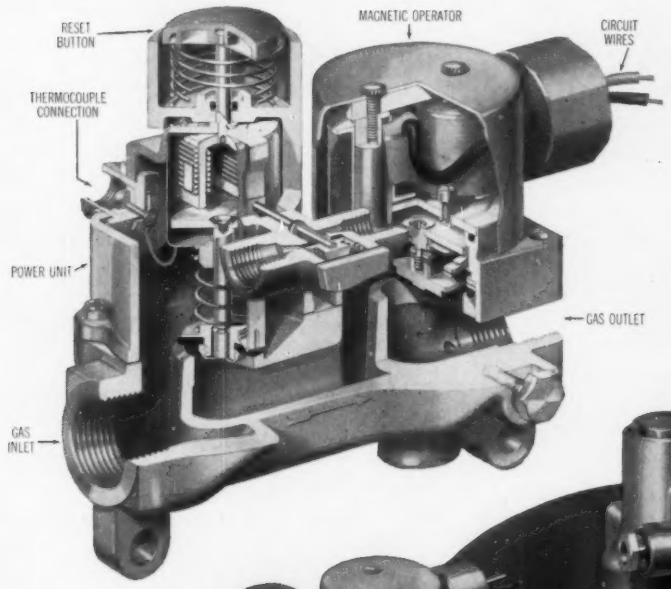
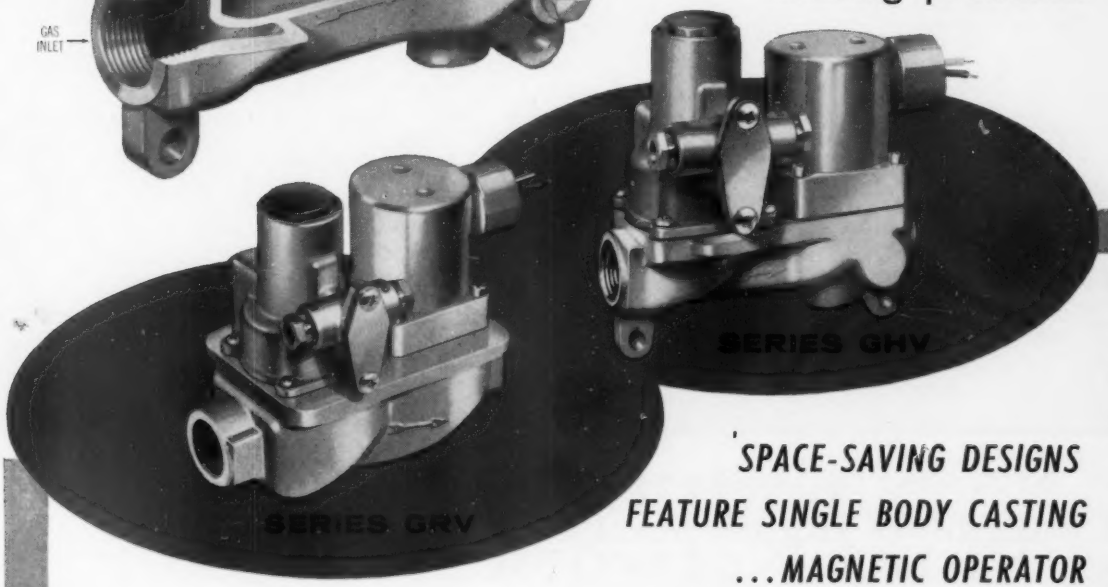


NEW!

BASOTROL® VALVES

for your gas heating products



SPACE-SAVING DESIGNS FEATURE SINGLE BODY CASTING ...MAGNETIC OPERATOR ...THERMOELECTRIC POWER UNIT

The silent-operating Basotrol® magnetic valves combine a single body casting, a Basotrol bipolar magnetic valve, and a Baso® thermoelectric power unit into a compact valve for easy installation. These controls can be provided in any position on the manifold and assure complete shutoff of main burner and pilot burner gas if the pilot burner should be extinguished.

The unique spring-loaded design of the new Series GHV2100 and GRV2100 magnetic valves permits mounting in any position because of strong sealing and positive closing. They are absolutely silent in operation because the oil-filled chamber dampens the action of the valve to assure soundless motion. Each Series of valves has independent pilot gas take-off, permitting mounting of the regulator either upstream or downstream from the valve.

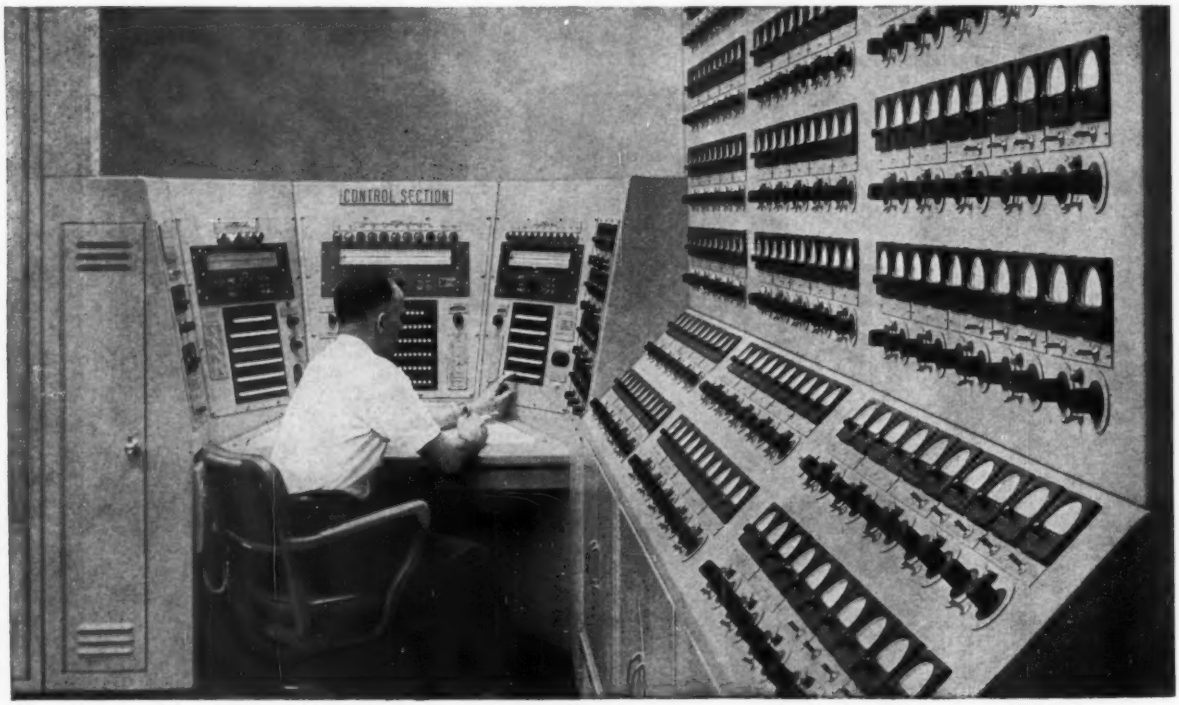
What's more, the unit can be mounted on the body in any of three positions. The Baso thermoelectric power unit can be placed in two positions. The body casting can have a manual control screw or pressure tapping in the same body.

Basotrol magnetic valves, Series GHV2100 and GRV2100, are available for either low or line voltage service—25v. and 115v., 60c., a.c. Series GHV natural gas capacity 70,000 Btu./hr. at 1″ P.D.; ⅜″ FPT inlet and outlet. Series GRV natural gas capacity 252,000 Btu./hr. at 1″ P.D.; ½″ FPT inlet and outlet.

For more information write Baso Inc., Dept. SC-3, Milwaukee 1, Wisconsin.

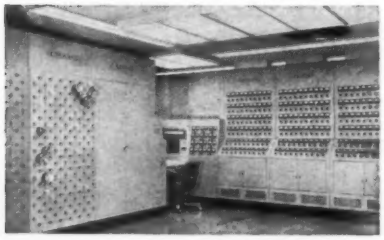
BASO INC. Milwaukee 1, Wisconsin

Bring Your System Planning Up-To-Date



...with the McIlroy Fluid Network Analyzer

Every utility that uses a McIlroy Fluid Network Analyzer is better informed on what its pipeline network is doing . . . how every pipe or valve is behaving and what it contributes to good service. And when it comes to network improvements or expansion, the McIlroy Analyzer tells, immediately, what to do, where, and how to do it to accomplish your objectives. It does so before you turn one shovelful of earth . . . before you spend one dollar on new material or labor. Why not let us prove it to you?



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TRADEMARK

THE STANDARD ELECTRIC TIME COMPANY

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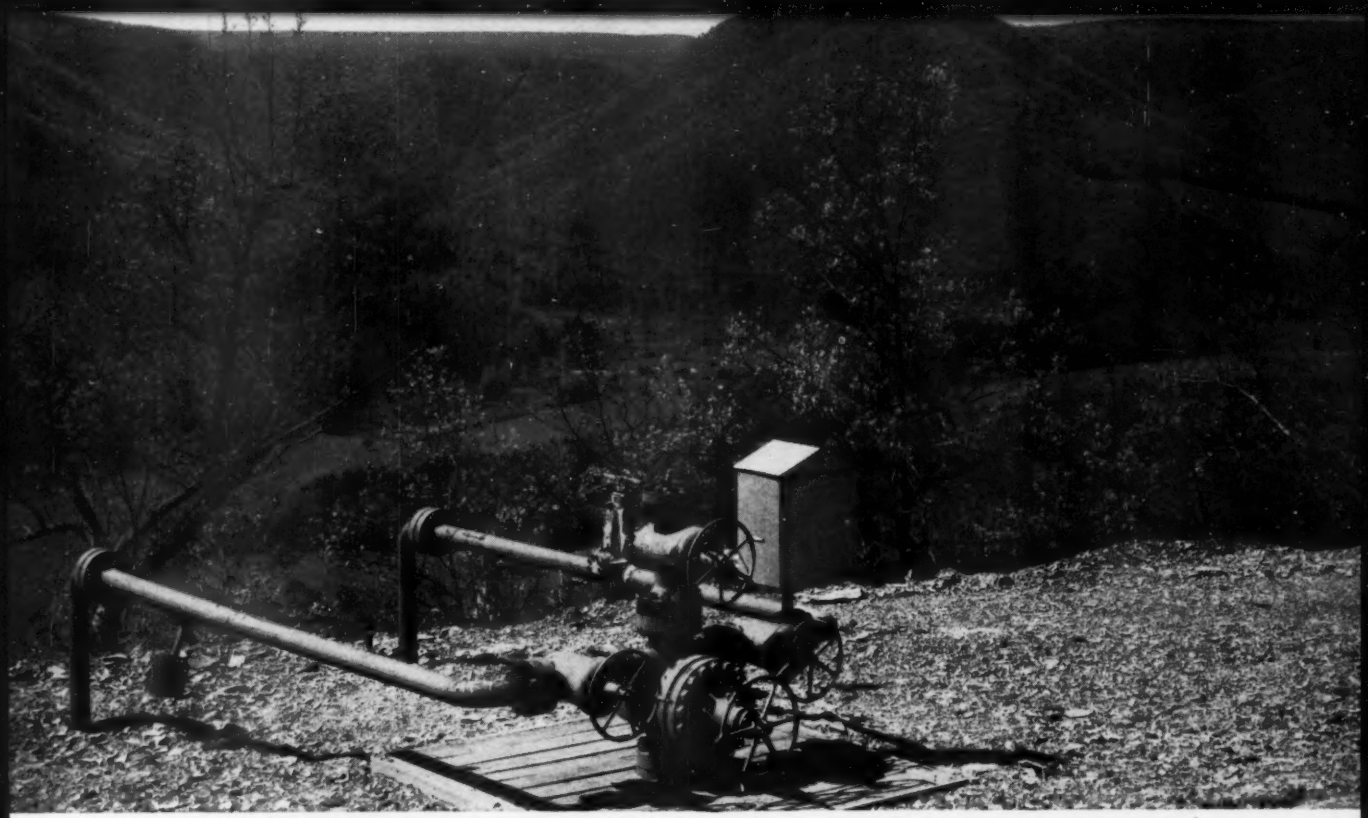


This National Supply wellhead is in operation on the LW-4 well in the Leidy gas storage field. Ultimately, the pool will store 105.7 billion cubic feet of gas for use by New York State Natural Gas Corporation, Transcontinental Gas Pipeline Corporation and the Texas Eastern Transmission Corporation. New York Natural will operate the facility.

Facts about new Leidy Storage Pool:

will store 105 billion cubic feet of gas
will operate under 4,000 pounds of pressure
will depend on 93 National Supply Wellheads

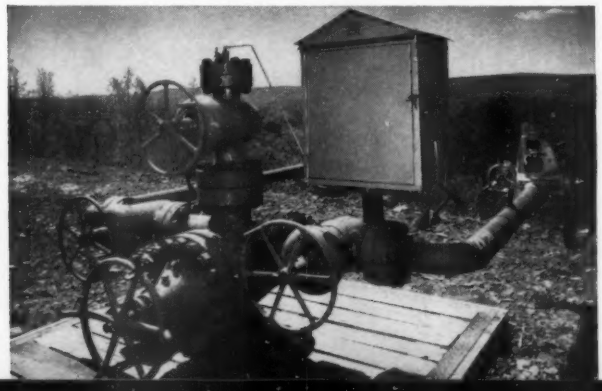
The famous Leidy gas pool is back in the news. A huge gas storage pool is being developed in this north-central Pennsylvania area to serve markets in Pennsylvania, New York and New Jersey.

When completed, the gas pool will be capable of holding 105.7 billion cubic feet of natural gas, including the 45 billion feet of cushion gas.

National Supply has furnished most of the wellheads for this vital new pool, which will be operated at a maximum of 4,000 pounds for storage, the greatest operating pressure of any pool ever developed.

There are many reasons why you usually find National Supply wellhead equipment at important installations such as this Leidy pool.

Pressures up to 4,000 pounds p.s.i. require the heavy duty piping and massive valves of this National Supply wellhead in the Leidy field.



National Supply manufactures a complete line of wellhead assemblies and is fully staffed to service all this equipment in the field. National Supply can design and supply complete wellheads to solve any of your special problems . . . whether they be with tubing hangers, bonnets, valves, flanged and threaded fittings, adjustable chokes and flow beans, flow assemblies, flow controls or specialty items.

For complete information, call your nearby National Supply store, or send in the coupon shown below.

Steel's Symbol of strength, long life, and economy

THE NATIONAL SUPPLY COMPANY

Two Gateway Center, Pittsburgh 22, Pennsylvania

Subsidiary of Armco Steel Corporation

The National Supply Company
Two Gateway Center, Pittsburgh 22, Pa.

I would like to know more about your wellhead equipment for gas storage wells.

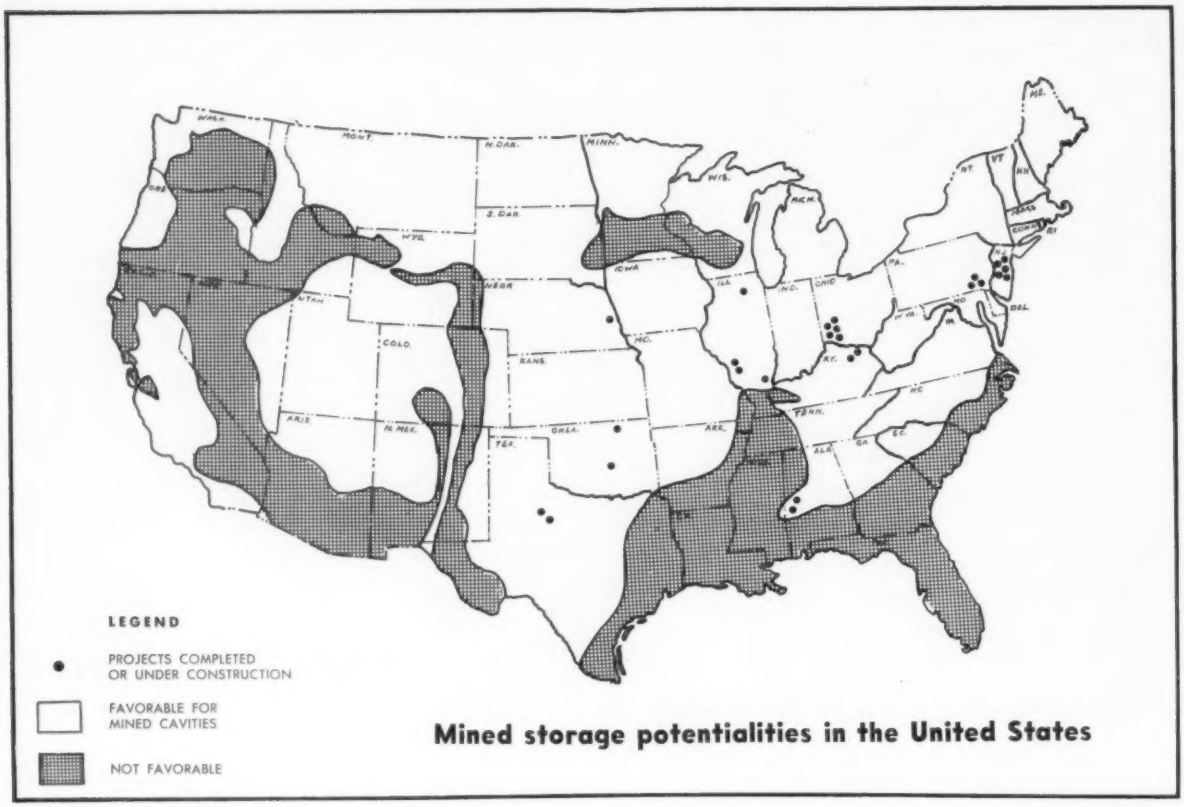
Name_____

Title_____

Company_____

Street Address_____

City_____ Zone_____ State_____



Mined storage potentialities in the United States

OVER 90% of all mined underground storage for L. P. GAS has been engineered and constructed by Fenix & Scisson, Inc.

A list of Fenix & Scisson Inc. projects

CLIENT—LOCATION	CAPACITY BBLS.	YEAR COMPLETED	EARTH FORMATION
Warren Petroleum Corporation			
Breckenridge, Texas	20,000	1950	Shale
Breckenridge, Texas	30,000	1952	Shale
Aurora, Illinois	50,000	1953	Shale
Crossville, Illinois	50,000	1953	Shale
Sinclair Oil & Gas Company			
Seminole, Oklahoma	110,000	1954	Shale
Tuloma Gas Products Co. & Sinclair Oil & Gas Company			
Demopolis, Alabama	140,000	1956	Chalk
Demopolis, Alabama	225,000	1956	Chalk
Esso Standard Oil Company			
Linden, New Jersey	150,000	1957	Shale
Linden, New Jersey	150,000	1957	Shale
Linden, New Jersey	100,000	1958	Shale
Linden, New Jersey	125,000	1958	Shale
Linden, New Jersey	150,000	1959	Shale
Sun Oil Company			
Marcus Hook, Pa.	250,000	1958	Granite
Marcus Hook, Pa.	400,000	*	Granite
Marcus Hook, Pa.	250,000	1960	Granite
Columbia Hydrocarbon Corporation			
Siloam, Kentucky	210,000	1959	Shale
Siloam, Kentucky	85,000	1959	Shale
Texas Eastern Transmission Corporation			
Middletown, Ohio	160,000	1959	Shale
Middletown, Ohio	210,000	1959	Shale
Middletown, Ohio	135,000	1959	Shale
Middletown, Ohio	165,000	1959	Shale
Middletown, Ohio	200,000	1960	Shale
Shell Oil Company			
Wood River, Illinois	500,000	1960	Limestone
Wood River, Illinois	250,000	*	Limestone
Metropolitan Utilities District			
Omaha, Nebraska	150,000	1960	Shale
Continental Oil Company			
Ponca City, Oklahoma	300,000	*	Limestone
TOTAL	4,565,000		

* Presently under construction.

Inquiries invited.

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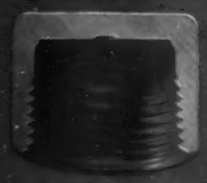
15" HANDLE



CAP

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← Four small guides which hold punch to its true axis.

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Each tee is tested to 5,000 p.s.i. hydraulic pressure, and carries "Rated 1,000 pounds". A 5 to 1 safety factor. Made from steel similar to pipe, it welds easily, and in the saddle model, takes a perfect thread.

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SOUTH BEND 21, INDIANA

GEM

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GAS

JULY 1960

Congressional probe of FPC hatches turkey

By NEIL REGEIMBAL
GAS Washington Bureau

A THEATRE critic would have labeled it a turkey. The anticipated drama of a congressional probe of Federal Power Commission dealings with the gas industry turned out to be a tragic comedy, poorly produced, with the heroes, villains, and victims of the plot frequently changing roles.

As the curtain fell, it was unclear whether the audience had seen the entire production, or only the first act. Many believed a repeat would turn into a complete farce.

In spite of its many shortcomings, the play did manage to make several points:

- There was nothing illegal about the *ex parte* contact between gas industry lawyers and members of the commission. A majority of the principals believed they may be improper, but companies defend them.
- These contacts were necessary because of the tremendous case backlog at the commission.
- The backlog is caused by procedures and policies hopelessly tangled by court rulings, by a lack of legislation, and by failure of the commission to draw definite regulatory roadways.
- Cost of unnecessary regulation to government (taxpayers) and to the gas companies (consumers) is tremendous.

GAS staff report

Symonds . . . Commanded

Corcoran . . . Contacted

Kuykendall . . . "Improper"

Chairman Oren Harris of the investigating committee supplied the epilogue to the two-week run by announcing that his production staff would continue looking into the FPC. He wound up by declaring that if necessary, he will personally plead for more money for the FPC and the other regulatory agencies next year. Legislation to curb one-sided conversations with members of the commission by industry officials may be passed next year, he said.

Almost from the beginning, the probe had an anticlimactic air.

The prologue was supplied a week before the curtain rose when FPC Commissioner Arthur Kline reported his office had been broken into and his desk rifled. A flurry of policy and congressional activity followed, but apparently the matter was permitted to die.

FPC Chairman Jerome K. Kuykendall, soft-spoken, mild-mannered, was first on the subcommittee's stage. On his second entrance, Mr. Kuykendall admitted he regarded as "improper" at least one call from another major character, Thomas G. Corcoran, made in behalf of Midwestern Gas Transmission Co. He put calls by a few other companies in this category, but defended contacts where merits of cases weren't discussed.

The FPC chairman was supposed to be one of the two casualties of at least embarrassment in the plot. He didn't suffer too badly. On later days, sitting quietly at the rear of the room, he watched the other supposed victim, Mr. Corcoran, suffer not at all.

Here are some of the highlights of Chairman Kuykendall's performance:

He denied that it is "accepted practice" for company officials to talk off-the-record with members of the commission about the merits of pending cases. But he admitted that conversations generally between firms and officials were common. He said in his seven years as a Republican chairman of the FPC, he has tried to adhere to standards of "honest, impartial service."

He denied that the FPC had come to a decision in the Midwestern case involving the Canadian gas import line which was later changed to an "open-end" rate of return. (The company, in its application for stock listing with the Securities & Exchange

The House Legislative Oversight Committee probing the commission. Chairman Oren Harris is at left.

FPC Commissioner Arthur Kline (left) and Chairman Jerome K. Kuydendall pour over a transcript of earlier testimony while waiting for hearings to resume.

Commission, noted that it expected to realize a 7 per cent return.)

Conversations between commission members and company spokesmen, such as those in which he said Mr. Corcoran discussed the need for a speedy decision in the Midwestern case and where a spokesman for Colorado Interstate on another occasion urged a quick decision to prevent financial difficulties, involved "procedural" matters, not the merits of cases, Mr. Kuykendall contended.

The chairman repeatedly emphasized that the FPC serves the consumer by insuring a healthy, growing gas industry. "It is not in the public interest for a company to go bankrupt," he said at one point.

Mr. Corcoran, known as "Tommy the Cork" when he was a top New Deal official, in the mid-1930s, turned out to be the real star of the show. His booming voice, piercing eyes, dark bushy eyebrows under silky, carefully groomed gray hair, gave the proceedings theatrical flavor.

There was even a hint of rehearsal. Before his first appearance, one of Corcoran's legal aids, when asked how he would arrive at the hearing for the benefit of photographers, said the witness was then "talking over his testimony" with Subcommittee Chairman Harris, and would walk in through the back door reserved for congressmen with the chairman. He did.

Tommy the Cork supplied the real comedy to the show. He interspersed angry rebuttals, lectures to the congressmen, a little piety, and sprinkled in sarcasm and condescension with his wit.

At one point while lecturing a member of the Subcommittee, he drew an angry order from one member to "stop winking at the chairman (Oren Harris) with your left eye." At another point, he complained that all these goings on had his ulcer acting up.

He stoutly denied that there was anything improper in his calls over the past 10 years at the FPC, particularly those involving the Midwestern case. Such calls are necessary, as anyone familiar with the huge FPC backlog knows, to cut through procedural difficulties, he contended.

He was rarely ruffled in the long hours of questioning, and often described questions from the lawmakers as "loaded," "repetitive," or of the "beating your wife" variety.

In one of his lectures, he contended that contacts such as he made with commission members were just as proper as letters from congressmen to the FPC supporting or opposing gas company applications. And these letters, he added, are "very desirable and helpful."

One member of the subcommittee said privately the night before Mr. Corcoran's second appearance that it was obvious that the witness was a "heavyweight" and perhaps mismatched in dealing with most government officials.

Mr. Corcoran rarely gave ground, and often left the audience wondering who was investigating whom. He politely questioned the memory of several other witnesses on details of earlier testimony. He once admitted under questioning that it might be possible to "conform to the law and still act with a high degree of impropriety." He staunchly contended that this was not so in his case.

The 60-year-old lawyer, who has been defending himself from similar charges successfully since he left the New Deal in 1939, insisted his visits to the commissioners were not "secret," and that he has a perfect right to talk to FPC members even about issues in pending cases, but that he did not because it would be "taboo." He also pointed out that the FPC staff has the right, although it may be an opponent, to talk the commissioners in private.

Subcommittee Chairman Harris inserted the moral into the show. He told Gardiner Symonds, head of Midwestern's parent, Tennessee Gas Transmission, that Mr. Corcoran's contacts with FPC members were made in an improper manner. "We've been unable to uncover any case so glaring and flagrant as this," the congressman said. It was at Mr. Symonds' direction that Mr. Corcoran contacted the chairman and two members of the commission.

Mr. Symonds, who also defended the right of the company to discuss procedure with FPC members, took much of the abuse which the antagonistic members of the subcommittee had been unable to fire effectively at Mr. Corcoran.

The executive, who pays Mr. Corcoran $60,000 a year, heard his firm's actions described as "high-handed," and accused of attempting to issue an "ultimatum" to the FPC. But Mr. Symonds, like Mr. Corcoran, refused to budge in his defense of such calls as necessary and not unusual. "Calls were made in complete compliance with the law," Mr. Symonds said, adding that the contacts were not secret.

N. W. Freeman, president of Midwestern, in defending the contacts, said that without them, "I question whether Tennessee (Gas Transmission) would be where it is today."

The other FPC commissioners told the congressmen of frequent talks with gas industry executives and lawyers, but all insisted they were not influenced on the merits of any cases.

As the House hearing ended, lawmakers on the other side of the Capitol took up the cry. Sen. Warren Magnuson (D., Wash.) announced the Senate Commerce Committee, of which he is now chairman, would make a sweeping probe of all six Federal regulatory commissions next year.

A few days after the congressmen finished clucking at the FPC and the gas industry, a raft of lawgivers themselves were on the spot, charged with widespread misuse and abuse of congressional expense account. Many had used funds for night clubbing, liquor, and vacation cruises instead of legislative activities, critics complained. "This must prove something," one weary gas industry spokesmen commented. ■

GAS exclusive

A liquid sealant called Con-Seal may end once and for all the problem of leaky bell-and-spigot joints in cast iron mains. Also important in this era of exploding populations, it permits upgrading low-pressure mains to medium-pressure service, so that much larger volumes of gas can be moved through existing systems.

Until now, there's been very little specific information about the material. While development work and extensive field trials have spanned almost a decade, Con-Seal has been under wraps until its creators were absolutely sure of their ground.

Here, then, is the first complete report on this important new-old development—an exclusive rundown on the experiences of seven companies who have treated almost 500,000 ft of main with Con-Seal. But first, in order to appraise the material in its proper perspective, the author reviews the problem and various solutions tried to date.

New liquid seal may end leaky joints

By E. O. HILBUSH, President
West Chester Chemical Co., West Chester, Pa.

LEAKAGE of bell-and-spigot joints is a growing problem. Most companies are faced with it now and those who have switched recently to natural gas can expect trouble soon.

At best, it's a costly nuisance. At worst, it is a serious hazard.

Some leakage can be expected when mains begin to grow old. Sections of piping shift or settle unevenly as the surrounding soil heaves, compacts or falls away from the main. Temperature changes cause the main to expand and contract, producing hairline separation around the cement or lead caulking. Ground water penetrates the joint and helps enlarge small breaks or fissures. And vibration from ever-increasing street traffic further weakens the joint.

Yet, serious leakage remains a rather isolated occurrence as long as the main is distributing wet manufactured gas. The relatively high moisture content of the gas keeps the jute or hemp joint packing in a fully swollen state. Moreover, hydrocarbons condensed from the gas stream fill interstices between the jute fibers to provide added protection against leakage.

Once a system is switched to dry manufactured or natural gas, however, trouble usually develops. Because moisture and condensable hydrocarbons are stripped from the gas before transmission, the jute packing begins to dry out, shrink and break down immediately after the changeover. And, since potential leakage sites have already been established by the ravages of time, the result is obvious.

There is no accurate estimate of how much gas is being lost in all parts of the country, but this much is known: it runs into untold millions of cubic feet per day. This in itself represents a serious dollar loss.

Less obvious, and perhaps more costly in the aggregate, is the expense of service calls due to clogged regulators and pilot outages. Most of these are a direct result of loose, dry dust in the main. Condensates from wet gas moisten and lay the accumulations of rust, powdered tar, jute and other residue, but the particles become highly mobile when they dry out. At times they build up to the point where they actually cut down the system's capacity.

• Current remedies

For more than 30 years, distribution engineers have been trying to halt leakage by some means other than digging down and repairing, replacing or clamping each joint. A variety of internal sealing methods have been proposed. Most of them soon proved impractical. Of the workable answers, the majority are generally acknowledged to be stop-gap measures with definite limitations.

The first direct approach, and one which is still practiced today, involved adding steam or water vapor to the gas stream. Fundamentally, rehydration does serve to swell the jute fibers in much the same way that wet manufactured gas maintains a leak-tight condition. But to be fully effective and reach all outlying parts of a system usually requires installation, operation and maintenance of a number of rehydrating

stations. On a continuing basis, this can become quite expensive.

Another drawback is that rehydration normally is stopped in winter months to preclude freeze-ups. Thus, deterioration progresses over a portion of the year. Alternate wetting and drying causes jute to powder, meter diaphragms become damaged, and corrosion is an ever-present problem.

Oil fogging also has considerable merit. It prevents complete drying out of joint packing and meter diaphragms, reduces corrosion, and lays dust deposits in mains. Because oil has very little swelling effect on jute fibers, this method is sometimes combined with rehydration to promote tight closure. However, oil fogging is most beneficial in terms of slowing further deterioration, rather than as a means of sealing joints which are already in bad shape.

Chemical additives are at present the most widely used means of internally treating leaky mains. Compounds are formulated to both increase the moisture-absorbing property of undamaged jute and to swell packing. While chemicals such as ethylene glycol (the familiar anti-freeze for automobiles) have the desired effect, they aren't permanent. Moreover, the treatment becomes less effective each time it's repeated. And finally, chemical additives require that something like 70 per cent of the original packing be present in the first place. Often this isn't the case in badly deteriorated joints. Because it depends on joint packing, this approach can't be used on cast-iron or steel systems having cemented, threaded, or universal joints.

To date, mechanical seals applied externally have been the surest way of sealing off badly leaking joints. The key to their relative permanence is the ability of modern elastomers like neoprene to resist for long periods of time the effects of soils moisture and chemicals.

Here, too, there are limitations. While the rubber gasket may remain resilient and seal completely as long as it's clamped tightly in place, what does fail eventually is the hardware. Also, clamping is fairly expensive, mainly because it usually requires street opening and digging at each joint. Depending on the particular job and what it involves in the way of cutting through pavement, repaving, reseeding and the like, clamping may cost anywhere from about $60 to more than $150 per joint.

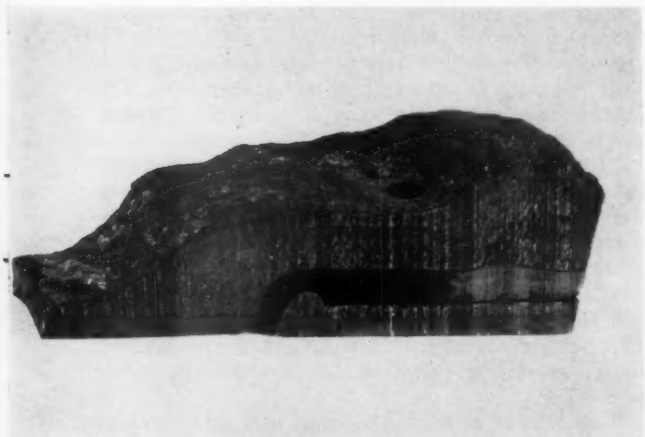
Con-Seal, developed by West Chester Chemical Co., West Chester, Pa., is a completely different type of internal sealant. At the same time, it bears some resemblance to other sealing methods in that it embodies many of their best features.

The material's active ingredient consists of finely-divided rubber-like particles dispersed in a neutral carrying fluid. This free-flowing suspension is pumped into a leaky main. It penetrates deeply into all joints, crevices and interstices. As capillary forces break the dispersion, all openings become filled with an elastic, non-fugitive solid which effects a complete seal. The material then self-cures, or polymerizes, to chemically link the particles into a tough, resilient, homogeneous mass.

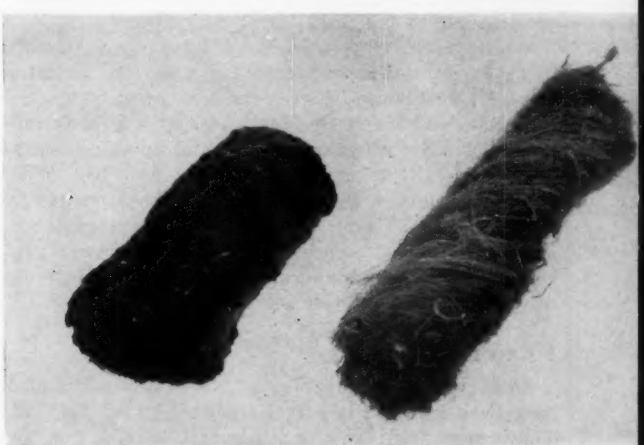
Being in liquid form, Con-Seal provides its own means of swelling the jute before locking it tightly into the joint. Because it has an elastomer base, it forms a flexible, rubber-like seal inside the joint instead of just partially reconstituting the packing. And, where external seals can be pushed away from the joint when bolts rust out, the Con-Seal closure is forced more firmly in place as gas pressure is increased.

The material has proved effective in mains where joint packing was badly deteriorated; in fact, it was found to seal cement-filled joints in which there was no packing whatsoever. It also seals leaky threads on service connections to mains, as well as steel mains assembled with threaded joints.

Apparently the seal will last indefinitely. A leading eastern utility ran exhaustive chemical tests to determine whether natural gas, its components or the commonly used odorizers and fogging oils have any deteriorating effect on the cured seal. It was found to be completely unaffected.



Section cut from treated main shows how sealant flows into the joint, saturates and swells the packing, and forms an impermeable barrier on the inside. Hairline separation between pipe and lead caulking is also closed off by the sealant.



That the new liquid sealant penetrates and swells joint packing is demonstrated by this comparison of treated and untreated jute. Material flows into and bridges all interstices between fibers, then cures to resilient, rubber-like seal.

Another important benefit of Con-Seal is that it eliminates problems arising from dirt in the mains. Much of the residue is carried out of the line when excess liquid is withdrawn after treatment and stored for future use. Whatever dirt remains in the system then becomes encapsulated and immobilized by the sealant.

• Method of application

The best means of applying Con-Seal is the patented "Never-Leak" method developed by Consolidated Edison Co. of New York Inc. It was described in a paper presented by C. P. Xenis at the AGA Distribution Conference in Cincinnati early last year.

Briefly, the procedure consists of a number of carefully planned steps which assure thorough sealing in the shortest possible time.

It begins with blocking off a convenient length of main—usually less than 2000 ft, although more than twice this length has been treated in a single operation. After pre-treatment leakage tests have been run, Con-Seal is pumped into the blanked-off section until the main is completely full. Filling takes place from the lowest point in the line, so that all air can be bled off at preselected points as the liquid level rises.

When filling is completed, moderate pressure is applied from the highest point in the section undergoing treatment. More Con-Seal is added from the pressurizing end to replace material which has begun flowing into the joints. Meanwhile, the line is patrolled in order to locate and quickly repair actual breaks or holes in the main. They're generally easy to spot, as the dark liquid forces its way up through soil or pavement.

Finally, when the flow of make-up material stops and pressure remains constant, pressure is increased to about 75 psig and held for at least 1.5 hours. Then the bulk of the material is withdrawn from the main through a hose-line filter and saved for future use. Recovery averages about 95 per cent.

Low-pressure mains are returned immediately to normal service. Medium-pressure mains are put on low-pressure service for a few weeks to assure complete curing of the seal.

While the process involves an outage to customers along the section being treated, it's usually a matter of only a few hours between the time services are cut and restored. The entire treatment of a 2000-ft section, including preparatory work and finishing operations, generally takes one working day or less. With two feed trucks, a 4800-ft section has been treated in one 8-hr shift. Users have found that customers are happy to cooperate, once commercial department personnel explain that the inconvenience is in the interest of supplying even better service.

• Experience to date

So far, six gas companies and one engineering firm have been involved in actual applications of Con-Seal. They range from very small properties to one of the country's largest utilities. Together, they constitute a cross-section of the industry as a whole, and their experience should typify the results than can be expected generally.

As reported in C. P. Xenis' paper at the AGA Distribution Conference, Consolidated Edison had treated a total of 143,307 ft of main by early 1959. This represents about 14,000 joints in both low and medium-pressure mains, with diameters ranging up to 16 in. In some cases, leakage before treatment ran as high as 390 cu ft per hr.

As shown in *Table 1*, Con-Seal applied by the Never-Leak method was an unqualified success. In every instance, leakage after treatment was an absolute zero. The first jobs, completed early in 1957, were still registering zero leakage at the time of this writing. Continued surveillance with infra-red detection equipment indicates that only three joints of all those treated ultimately developed leaks. All three occurred in the same section of main.

Last year, since the Xenis report, Con Edison treated an additional 148,000 ft of main to bring the total to almost 60 miles. Of this, about 245,000 ft lies in suburban Westchester county, some 40,000 ft in the Bronx, and about 6000 ft in Manhattan. Results have been equally good on subsequent jobs. Therefore, the company has added to its application equipment for a broadened program during 1960.

Con Edison is using between 0.5 to 1 gal. of Con-Seal per joint, depending upon diameter of the main being treated. The average of all mains treated runs about 0.9 gal. per joint, which of course includes material remaining on pipe walls between the actual joints. While no cost figures have been released, the company does say it expects this work to pay for itself in 13 years, just in terms of the gas it saves.

To date, the largest mains treated by Con Edison on a production basis have been 16-in. lines; but experimental work on much larger mains is in progress. One section of 24-in. main, which had been leaking 12 cu ft per hr at 10 psig, was sealed completely. However, indications are that special techniques will be needed for mains of this size.

Another large metropolitan utility treated four sections of 4-in. and 6-in. mains during June 1959. Total footage treated was 3400 ft, with 230 joints.

Tests made with a meter immediately after treatment was completed indicated the leakage had been reduced to zero on all four sections.

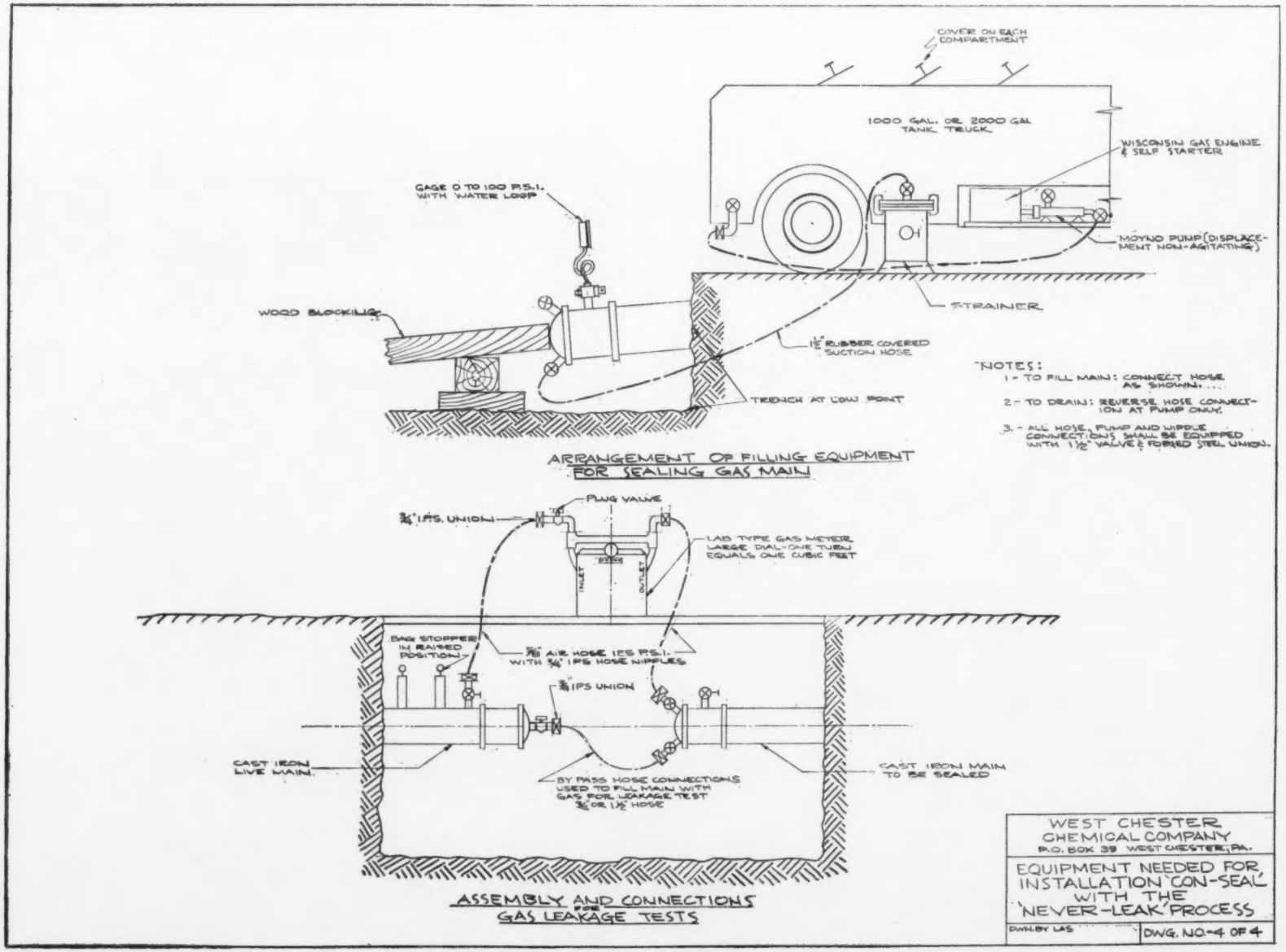
As shown in *Table 2*, cost per joint averaged $41.36, with one section running only $31.64 per joint. The cost of clamping in the same area averaged $59.02 per joint for a 61-joint section of 6-in. main.

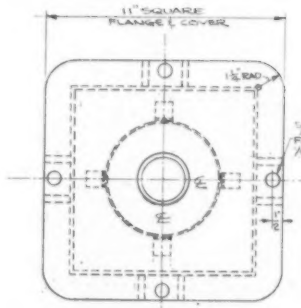
Treatment costs were influenced by the fact that the equipment used, some of the labor, and most of the Con-Seal were rented or purchased from a neighboring utility. Costs therefore included transportation, overhead and handling charges.

The company has since assembled its own equipment and purchased a quantity of Con-Seal for use in its 1960 sealing operations. It is felt that with its own equipment and more experience, treatment costs can be reduced.

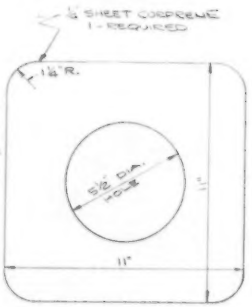
Ford, Bacon & Davis, Inc. has also been licensed

Drawings on the following four pages show suggested equipment. *Text continues on page 53.*

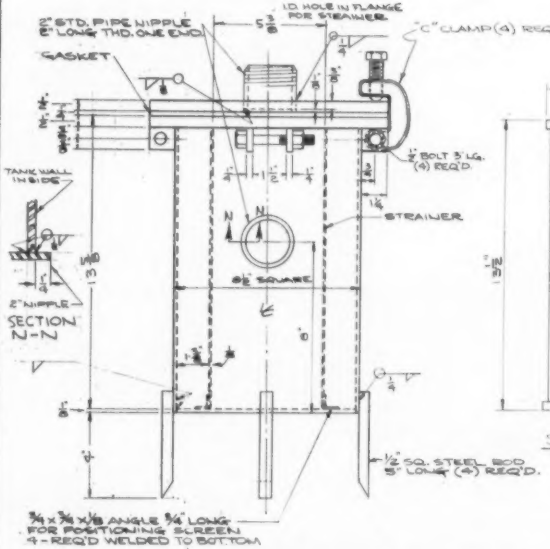

COVER ON EACH COMPARTMENT
1000 GAL. OR 2000 GAL TANK TRUCK
WISCONSIN GAS ENGINE & SELF STARTER
MOYNO PUMP (DISPLACEMENT NON-AGITATING)
GAGE 0 TO 100 P.S.I. WITH WATER LOOP
WOOD BLOCKING
STRAINER
1½" RUBBER COVERED SUCTION HOSE
TRENCH AT LOW POINT
NOTES:
1 - TO FILL MAIN: CONNECT HOSE AS SHOWN.
2 - TO DRAIN: REVERSE HOSE CONNECTION AT PUMP ONLY.
3 - ALL HOSE, PUMP AND NIPPLE CONNECTIONS SHALL BE EQUIPPED WITH 1½" VALVE & FORGED STEL UNION.
ARRANGEMENT OF FILLING EQUIPMENT FOR SEALING GAS MAIN
PLUG VALVE
¾" I.P.S. UNION
LAB TYPE GAS METER LARGE DIAL - ONE TURN EQUALS ONE CUBIC FEET
INLET
OUTLET
BAG STOPPER IN RAISED POSITION
⅜" AIR HOSE 125 P.S.I. WITH ¾" IPS HOSE NIPPLES
¾" IPS UNION
CAST IRON LIVE MAIN
BY PASS HOSE CONNECTIONS USED TO FILL MAIN WITH GAS FOR LEAKAGE TEST ¾" OR 1½" HOSE
CAST IRON MAIN TO BE SEALED
ASSEMBLY AND CONNECTIONS FOR GAS LEAKAGE TESTS
WEST CHESTER CHEMICAL COMPANY
P.O. BOX 39 WEST CHESTER, PA.
EQUIPMENT NEEDED FOR INSTALLATION 'CON-SEAL' WITH THE 'NEVER-LEAK' PROCESS
DWN. BY LAS
DWG. NO.-4 OF 4



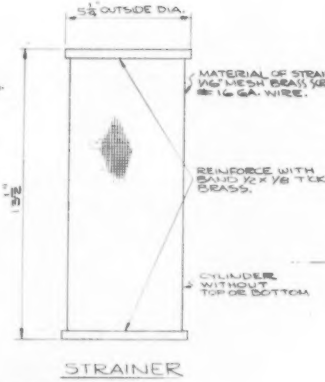
PLAN & COVER



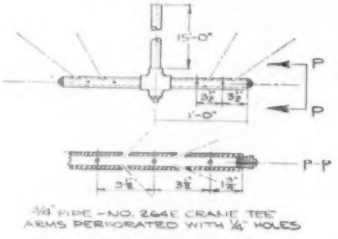
GASKET


2" STD. PIPE NIPPLE 6" LONG THD. ONE END
I.D. HOLE IN FLANGE FOR STRAINER
"C" CLAMP (4) REQ'D.
GASKET
⅜" BOLT 3" LG. (4) REQ'D.
TANK WALL INSIDE
STRAINER
8" SQUARE
2" NIPPLE
SECTION N-N
½ SQ. STEEL ROD 5" LONG (4) REQ'D.
¾ x ¾ x ⅛ ANGLE ¾" LONG FOR POSITIONING SCREEN 4-REQ'D WELDED TO BOTTOM

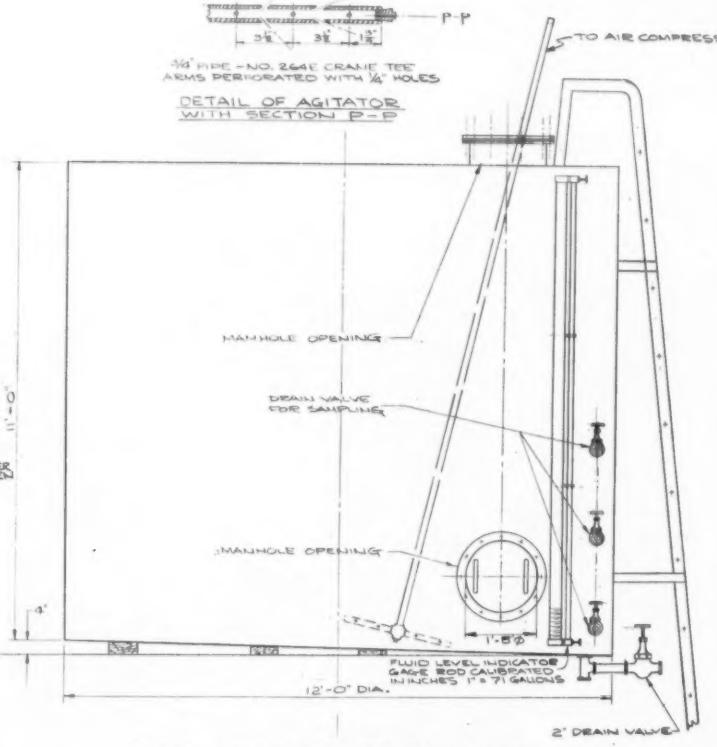
STRAINER FOR SEALING GAS MAINS


5⅛ OUTSIDE DIA.
MATERIAL OF STRAINER 1/16" MESH BRASS SCREEN OF 14 GA. WIRE.
REINFORCE WITH BAND ½ x ⅛ THK. BRASS.
CYLINDER WITHOUT TOP OR BOTTOM

STRAINER

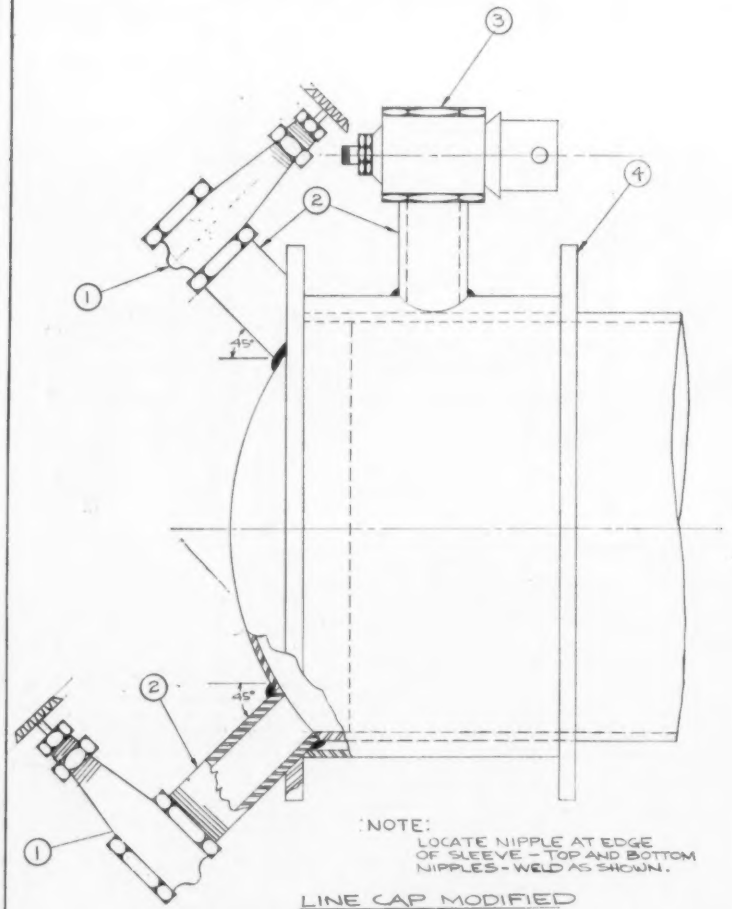


DETAIL OF AGITATOR WITH SECTION P-P



10,000 GALLON STORAGE TANK

WEST CHESTER CHEMICAL COMPANY P.O. BOX 59 WEST CHESTER, PA.	
EQUIPMENT NEEDED FOR INSTALLATION 'CON-SEAL' WITH THE 'NEVER-LEAK' PROCESS	
DWN. BY LAS	DWG. NO.-2 OF 4

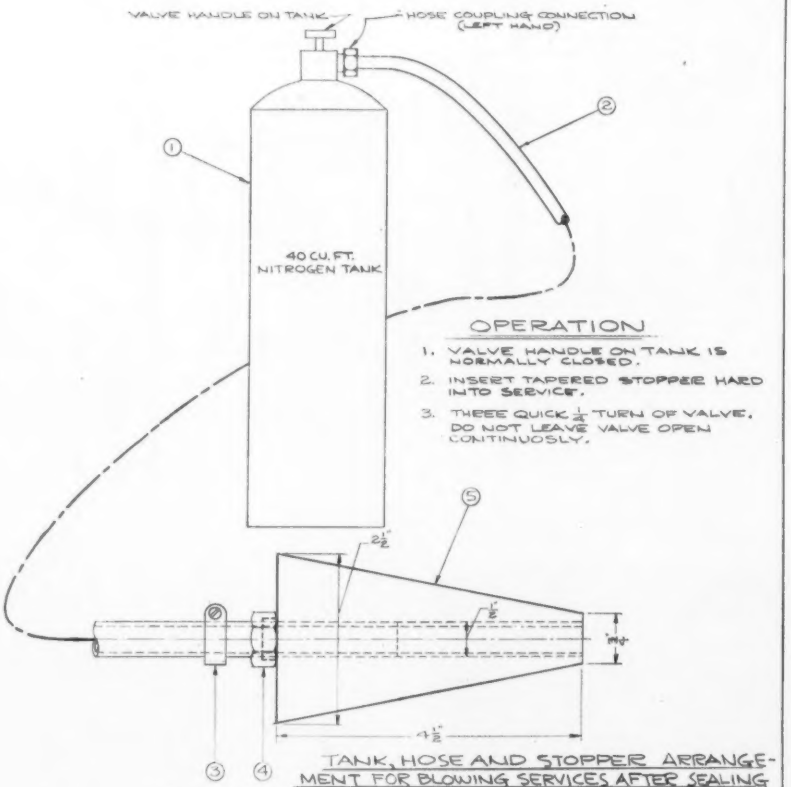


NOTE:
LOCATE NIPPLE AT EDGE OF SLEEVE – TOP AND BOTTOM NIPPLES – WELD AS SHOWN.

LINE CAP MODIFIED FOR 'NEVER LEAK' METHOD

BILL OF MATERIAL

ITEM	QUAN.	DESCRIPTION	DWG. OR SPEC. NO.
1	2	1½" GATE VALVE	
2	3	1-½" NIPPLE - 3" LG.	
3	1	1-½ PLUG VALVE	
4	1	DRESSER LINE	
		CAP STYLE 31	



OPERATION

1. VALVE HANDLE ON TANK IS NORMALLY CLOSED.
2. INSERT TAPERED STOPPER HARD INTO SERVICE.
3. THREE QUICK ¼ TURN OF VALVE. DO NOT LEAVE VALVE OPEN CONTINUOUSLY.

TANK, HOSE AND STOPPER ARRANGEMENT FOR BLOWING SERVICES AFTER SEALING

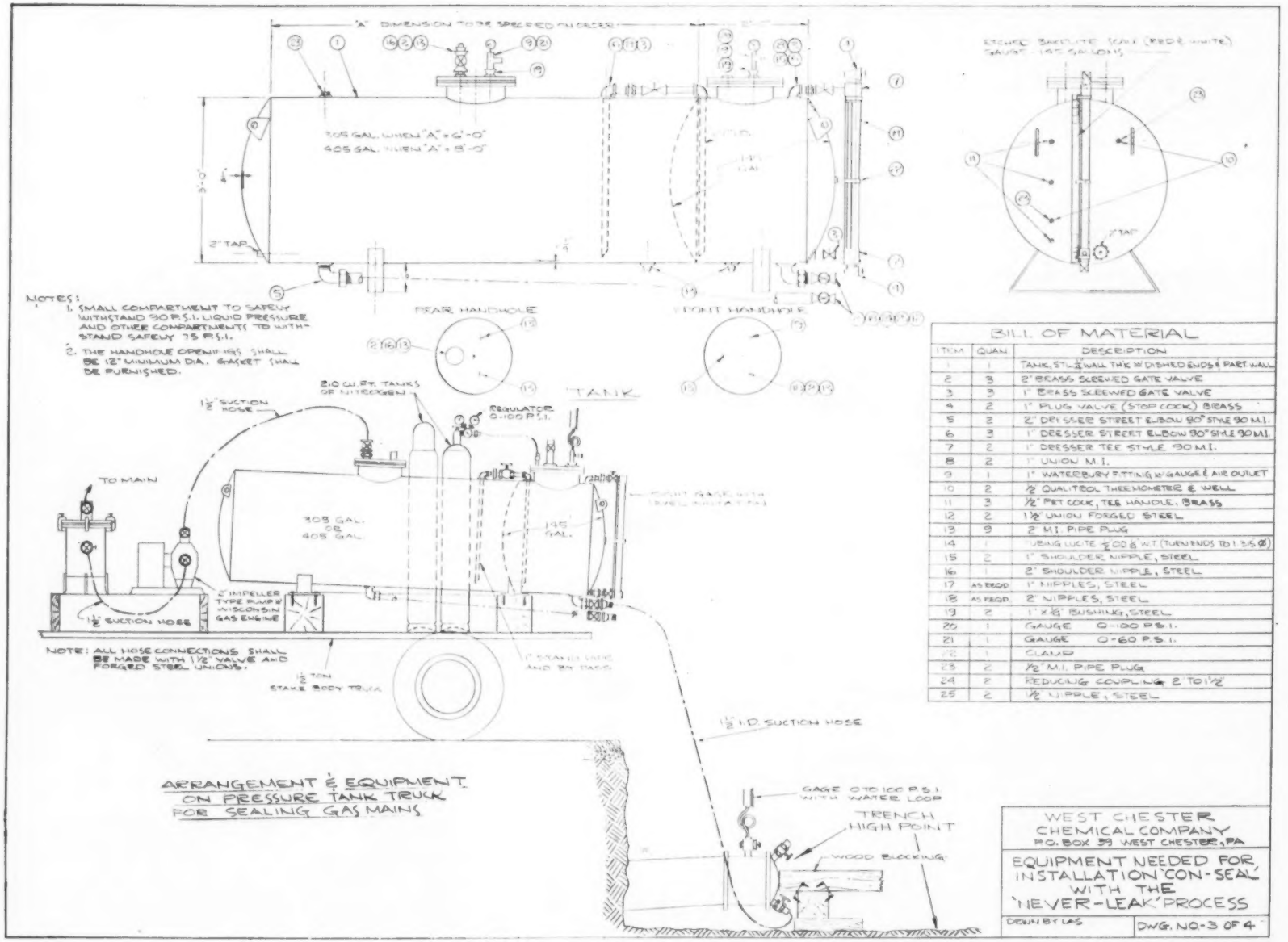
BILL OF MATERIAL

ITEM	DESCRIPTION	DWG. OR SPEC. NO.
1	40 CU. FT. NITROGEN TANK	
2	½" AIR HOSE (125 P.S.I.) W/ ½" I.P.S. HOSE NIPPLE - 6" LG.	
3	HOSE CLAMP	
4	⅜" HOSE NIPPLE FOR ½" I.D. HOSE	
5	TAPERED RUBBER STOPPER W/ ½" HOLE SUITABLE FOR PIPE ¾" TO 2" INCLUSIVE.	

WEST CHESTER CHEMICAL COMPANY
P.O. BOX 98 WEST CHESTER, PA.

EQUIPMENT NEEDED FOR INSTALLATION CON-SEAL WITH THE 'NEVER-LEAK' PROCESS

DRWN. BY LAS | DWG. NO. - 1 OF 4


"A" DIMENSION TO BE SPECIFIED ON ORDER
305 GAL. WHEN "A" = 6'-0"
405 GAL. WHEN "A" = 8'-0"
2" TAP
REAR HANDHOLE
FRONT HANDHOLE
ETCHED BAKELITE (CAP, BODY & WHITE)
GAUGE 185 GALLONS
2" TAP
NOTES:
1. SMALL COMPARTMENT TO SAFELY WITHSTAND 30 P.S.I. LIQUID PRESSURE AND OTHER COMPARTMENTS TO WITHSTAND SAFELY 75 P.S.I.
2. THE HANDHOLE OPENINGS SHALL BE 12" MINIMUM DIA. GASKET SHALL BE FURNISHED.
TANK
1½" SUCTION HOSE
210 CU. FT. TANKS OF NITROGEN
REGULATOR 0-100 P.S.I.
TO MAIN
305 GAL. OR 405 GAL.
185 GAL.
2" IMPELLER TYPE PUMP W/ WISCONSIN GAS ENGINE
1½" SUCTION HOSE
NOTE: ALL HOSE CONNECTIONS SHALL BE MADE WITH 1½" VALVE AND FORGED STEEL UNIONS.
1½ TON STAKE BODY TRUCK
1½" I.D. SUCTION HOSE
GAGE 0 TO 100 P.S.I. WITH WATER LOOP
TRENCH HIGH POINT
WOOD BLOCKING

ARRANGEMENT & EQUIPMENT ON PRESSURE TANK TRUCK FOR SEALING GAS MAINS

BILL OF MATERIAL

ITEM	QUAN.	DESCRIPTION
1	1	TANK, STL. ¼" WALL THK W/ DISHED ENDS & PART WALL
2	3	2" BRASS SCREWED GATE VALVE
3	3	1" BRASS SCREWED GATE VALVE
4	2	1" PLUG VALVE (STOP COCK) BRASS
5	2	2" DRESSER STREET ELBOW 90° STYLE 90 M.I.
6	3	1" DRESSER STREET ELBOW 90° STYLE 90 M.I.
7	2	1" DRESSER TEE STYLE 90 M.I.
8	2	1" UNION M.I.
9	1	1" WATERBURY FITTING W/ GAUGE & AIR OUTLET
10	2	½ QUALITROL THERMOMETER & WELL
11	3	½" PET COCK, TEE HANDLE, BRASS
12	2	1½ UNION FORGED STEEL
13	9	2" M.I. PIPE PLUG
14	1	PLEXIGLASS ¼ OD & ⅛ W.T. (TURN ENDS TO 1.375 Ø)
15	2	1" SHOULDER NIPPLE, STEEL
16	1	2" SHOULDER NIPPLE, STEEL
17	AS REQD.	1" NIPPLES, STEEL
18	AS REQD.	2" NIPPLES, STEEL
19	2	1" x ½" BUSHING, STEEL
20	1	GAUGE 0-100 P.S.I.
21	1	GAUGE 0-60 P.S.I.
22	1	CLAMP
23	2	½" M.I. PIPE PLUG
24	2	REDUCING COUPLING 2" TO 1½"
25	2	½ NIPPLE, STEEL

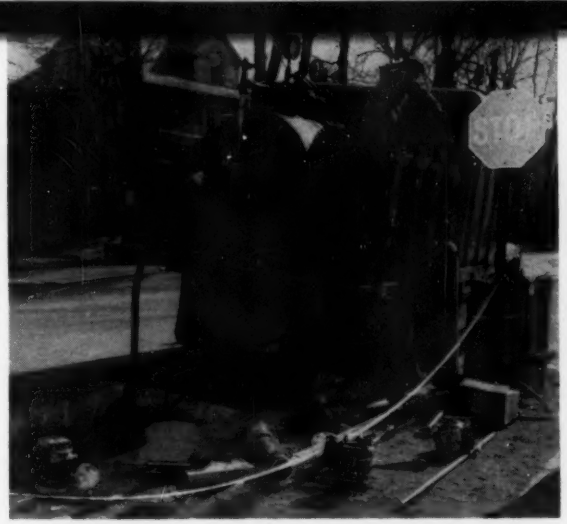
WEST CHESTER CHEMICAL COMPANY
P.O. BOX 39 WEST CHESTER, PA

EQUIPMENT NEEDED FOR INSTALLATION 'CON-SEAL' WITH THE 'NEVER-LEAK' PROCESS

DRWN BY LAS | DWG. NO. 3 OF 4

by Con Edison to use the Never-Leak method of applying Con-Seal. To date, the firm has handled three jobs —a 300-ft test section of 12-in. main in Elizabethtown, N. J., and a total of 3240 ft of main near Poughkeepsie, N. Y.

According to FB&D's W. D. Kleppinger, treatment proved eminently successful in all three cases; leakage was reduced from as much as 50 cu ft per hr to zero after treatment. Subsequent tests (roughly a month later) continued to indicate no measurable leakage.



After filling, main is pressurized from highest point in section, with pressure from gas bottles. Pressurizing truck is equipped for measuring amount of make-up material added during sealing; also carries several hundred gallons of extra material in separate tank compartment.

TABLE 1. Results obtained by Con Edison[1]

Summary of gas mains treated with Con-Seal

Pipe ID, Inches	Total No. of Feet Treated
2	720*
3	5,881
4	77,991
6	45,755
8	7,527
10	390
12	4,933
16	110
Grand total	143,307

* Steel and wrought iron.

Typical low-pressure cast iron gas mains treated with Con-Seal

Pipe ID, Inches	Length of Main Treated, Ft	Leakage, Cu Ft/Hr	
		Before	After
4	849	15	0
4	1290	39	0
4	1370	72	0
6	600	19	0
6	1200	69	0
6	1410	63	0
8	620	50	0

Low Pressure: 4–8 Inches Water Column
A section of 2-inch steel pipe with threaded joints and services was treated, and the leakage through the threads was stopped.

Typical medium-pressure cast iron gas mains treated with Con-Seal

Pipe ID, Inches	Length of Main Treated, Ft	Leakage, Cu Ft/Hr	
		Before	After
4	842	68	0
4	1472	61	0
4	1689	67	0
6	813	73	0
6	1410	63	0
6	1150	236	0
4 & 6	4880	390	0

Medium Pressure: 2–15 psi

Summary
Infra-Red Detection Program

155 sections of gas main treated – 143,307 ft.
120 sections – no leaks reported
35 sections – leaks reported
Investigation of the 35 sections showed 30 leaks

No. of Leaks	Description of Leaks
3*	Joint leaking.
9	Packing leaking on main valves and leaking curb valves.
2	Leaking 2-inch services.
10	No indication of natural gas.
6	Still under investigation.

* The three joints found leaking were all in the same section treated.

[1] As reported in paper presented by C. P. Xenis at the AGA Distribution Conference in Cincinnati, April 6, 1959.

After careful observation of Con Edison's experience and independent studies of its own, the engineering firm is now certifying treated mains for operation at higher operating pressures. As an example, FB&D certified the two 10-psig booster lines near Poughkeepsie for operation at 40 psig, in accordance with ASA B-31.8-1958. In fact, they're recommending that all low-pressure mains treated in this manner be upgraded to medium-pressure service.

Central Hudson Gas & Electric Co., Poughkeepsie, the company for which Ford, Bacon & Davis treated 3240 ft of main during August of last year, is very well satisfied with the results obtained.

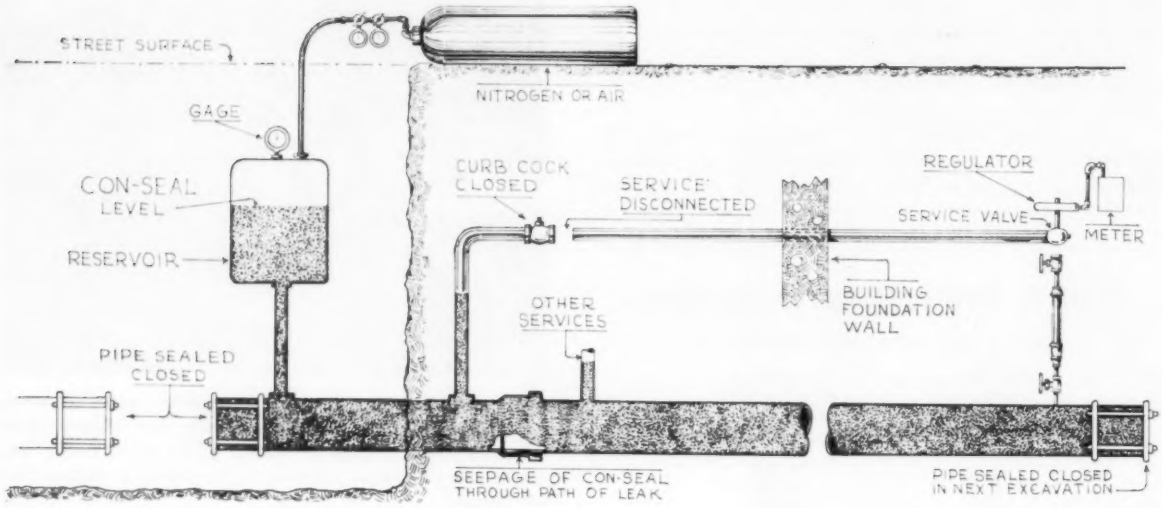
One of the jobs was a 740-ft section of 10-in. main on Hasbrouck Ave. in Kingston, N. Y. The other was 2500 ft of a 4-mile, 6-in. main between Kingston and Saugerties, known as the K-S line.

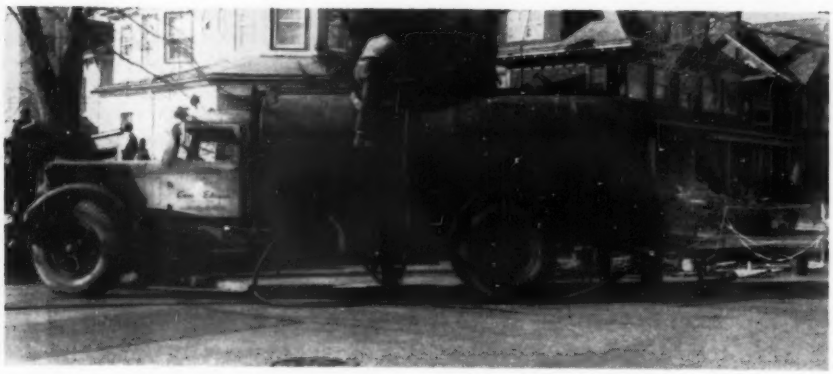
The entire treatment program spanned five days, including preparation and equipment setup, cutting of mains and services, before-and-after leakage testing, and putting the mains back in service. Actual treatment in each case was a matter of just a few hours.

Central Hudson's working schedule (see *Table 3*) called for an 11-hr service interruption on each half of the K-S line. Work actually progressed so smoothly that treatment was completed by about 10:30 a.m. Following post-treatment leakage tests, services were being reconnected by 2 o'clock that afternoon.

Both mains were what the company terms "specialty jobs." Most of the K-S line is situated well under the concrete pavement of a busy highway. Clamping would have involved considerable chopping, tunnelling, interference with traffic and repaving. With some 200 joints in the section to be sealed, the cost of clamping was estimated at about $25,000.

As for the Hasbrouck avenue job, all other parts of the main had been clamped previously. Since the street was completely repaved, the city was reluctant to issue street-opening permits for Central Hudson to clamp





ABOVE: Con Edison's Never-Leak method assures complete filling through elimination of air pockets, forces sealant into joints under moderate pressure. Excess material is drained off and reused.

LEFT: A 4500-gph displacement-type pump mounted on 2000-gal. tank truck is used for filling and draining operations.

LEFT: Typical hookup for treatment shows modified line caps in place. Live main, rigged for leakage testing, is at upper right. Main to be treated is in foreground. Pressure gauge with water loop will be attached to vertical fitting, while filling hose goes on valved connecton near bottom of pit. Wood blocking is safeguard in event of blowoff. BELOW: With treatment in progress, sealant flows through large hose into main at upper left. Section at lower right is live main equipped for post-treatment leakage test.

the remaining section of this medium-pressure line. Even if permission had been granted, the company says clamping would have been very expensive—in the neighborhood of $6000.

Because this was its first experience with the Never-Leak method of treatment, Central Hudson approached the job with considerable caution. A good bit of time was spent in preliminary contacts with customers affected by the work to insure proper acceptance of the anticipated 8- to 12-hr service interruption. Preparations were made to cope with situations such as possible loss of Con-Seal through a broken main or service fitting—which, fortunately, never materialized. And, in order to familiarize as many men as possible with the Never-Leak procedure, extra crews were scheduled on the job.

All of these factors contributed to a final cost of almost $18,000—somewhat in excess of the original $14,200 estimate for both jobs. Still, Central Hudson figures it realized worthwhile savings by using the Never-Leak method in place of clamping the mains.

With about 100 miles of cast iron mains, the company says it undoubtedly has a number of other "specialty" jobs where the new sealing method can effect substantial savings. And with refinements in technique resulting from additional experience, Central Hudson expects the process to find even greater application in its system.

Milwaukee Gas Light Co. treated a 640-ft section of 4-in. main in October 1959. Leakage before treatment ran 15.3 cu ft per hr, and zero afterward. The company has set up equipment to isolate the treated section and make periodic measurements of losses, if any. To date there have been none.

Consumers' Gas Co., Toronto, decided on the basis of Con Edison's success to treat a section of main in Ottawa. The section chosen involved two parallel 8-in. lines on Rideau St., an area in which the mains were known to be more than 50 years old. Pavement extends from building to building on each side of the street and traffic usually is quite heavy.

A fairly recent conversion from manufactured to natural gas resulted in a temporary excess main capacity in this area, so it was possible to take one of the mains completely out of service.

By the time the necessary equipment was rounded up, however, cold weather had set in and temperatures were dipping as low as 15 deg F during some of the sealing operations. Since Con-Seal would freeze at this level, it proved necessary to supply heat to tanks and hoses. This was done by wrapping them with insulation over 0.5-in. copper steam tubing. As a result, temperature of the sealant was kept at about 90 deg F throughout the operation. According to R. I. Jones, design and development engineer, "Continuing leakage survey through this area leads us to believe that the main is completely sealed . . ."

Hookup for checking leakage before and after treatment routes gas from live main through meter to sealed section.

Citizens Gas & Fuel Co., a subsidiary of Penn Fuel Gas Co., has treated more than 6000 ft of 4- and 6-in. main in Oxford, Pa. A good portion of the work was performed on universal pipe, which is difficult to seal by usual methods. Several other sections were also treated in properties the parent company operates at Ashland and Mt. Carmel. Most of these lines are intermediate-pressure mains operating at 3 psig; sections

TABLE 2. Cost experience of a metropolitan utility

Job No.	1.	2.	3.	4.	Average, all four jobs	Clamping in same area
Diameter of main, in.	4	6	6	4	—	6
Length of section treated, ft	600	1200	750	850	850	732
Number of joints	50	67	42	71	57.5	61
Number of services	12	17	9(a)	13	—	—
Cost of material(b)	663.92	541.28	840.10	863.45	—	—
Other costs(c)	1738.15	1806.88	1698.03	1383.19	—	—
Total cost	2402.07	2348.16	2538.13	2246.64	2383.75	3600.22
Cost per foot	4.03	1.96	3.38	2.64	2.80	4.92
Cost per joint	48.04	35.05	63.40	31.64	41.46	59.02
Cost per meter	200.17	138.13	16.92	172.79	—	—

(a) Multi-family dwellings with 120 meters on 9 services; other three jobs were single-family houses.
(b) Bulk of material was purchased from a neighboring utility and so includes mark-up for added handling and transportation.
(c) Includes all direct labor costs, auto hours, seeding and paving, as well as charges for equipment, labor transportation and supervision supplied by the neighboring utility.

TABLE 3. Typical working schedule set up by Central Hudson

Time	Work
7:00 a.m.	Start to disconnect services.
7:30	All customers disconnected. Shut by-pass at each end and start one hour leakage test at 8 lb.
8:30	End leakage test. Contractor to start pumping in Con-Seal.
10:30	Complete filling operation. Start 75-lb pressure run.
11:30	Complete 75-lb pressure run.
11:30—12:30	Free time for contingencies.
12:30 p.m.	Start to remove Con-Seal.
1:30*	Complete removal of liquid. Purge section of line and start one-hour leakage test at 8 lb.
3:30	Complete leakage test. Reduce pressure in line and connect piping to admit low-pressure gas.
4:00*	Start reestablishing service to customers.
5:00	Service established to all customers.
5:00—6:00	Free time for contingencies.

*Work actually progressed so smoothly that treatment was completed by about 10:30 a.m. and services were being re-established by 2:00 p.m.

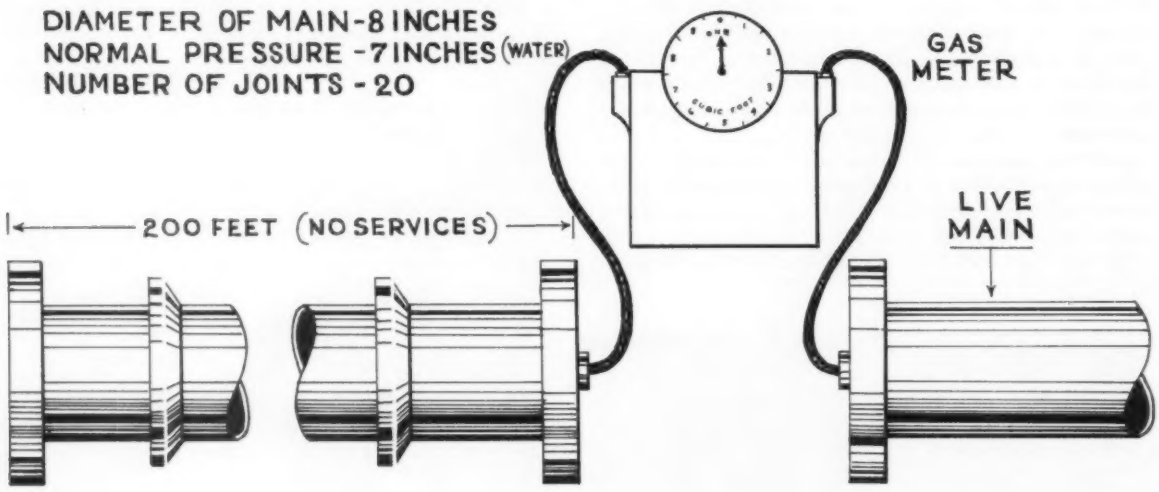
treated averaged between 500 and 600 ft in length, and included 3-, 4- and 6-in. mains.

Leakage, which ran 30 to 50 cu ft per hr before treatment, was stopped completely. The cost averaged only 90 cents per ft, or just $7.38 per joint for material and labor (but excluding supervision, as well as wear and tear and depreciation on trucks). This compares with an average cost of about $30 for clamping 4-in. mains in the same area. C. E. Martin, vice president and operating manager, attributes their remarkably low cost to the much lower overhead of a small company.

Probably even more significant savings will be reported by the several utilities when they're able to determine the full effects of fewer service calls, less corrosion and lower maintenance costs.

Meanwhile, a number of other companies have begun experimenting with Con-Seal. Experience has shown that the best way of determining its capabilities under a given set of conditions is to make provisions for running periodic checks on the test section in the ground. While removing segments of joints for testing in the laboratory does provide visual assurance of sealing, results obtained in this manner have proved somewhat inconclusive—probably because of physical damage due to cutting and handling.

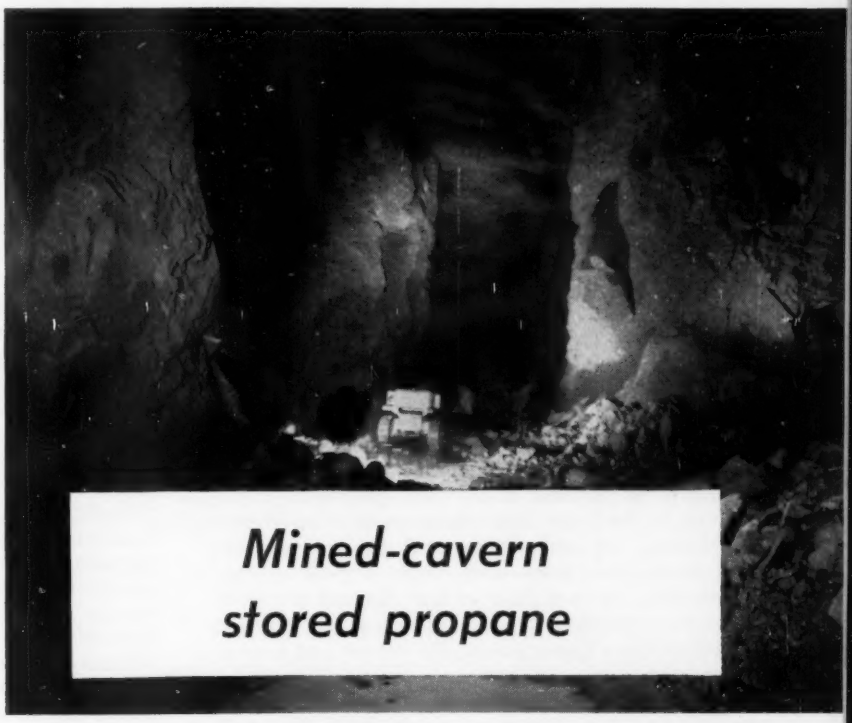
In summary, Con-Seal appears to perform well under a variety of conditions; with a background of almost 10 years of testing by utilities and some actual applications now more than three years old, indications are that its effects are lasting. And finally, there's ample evidence of important savings, both in sealing costs and indirect benefits. ■



MAIN TREATED - MAY 9, 1957
GAS LEAKAGE TEST - BEFORE TREATMENT - 24 CU FT/HR
" " " AFTER TREATMENT - ZERO
" " " SEPT. 18, 1958 - NO LEAKAGE (16 MONTHS)
" " " FEB. 3, 1959 - NO LEAKAGE (21 MONTHS)

For practical check on permanence, Con Edison has kept several sections of deadend mains sealed off from rest of system. Periodic checks have shown no loss of gas to date.

Your best bet for large-scale peak shaving



Mined-cavern stored propane

By G. J. FENIX • Fenix & Scisson Inc.

DURING a recent nine-year period, total annual sales of a typical large integrated gas company increased 184.5 per cent. During the same nine years, peak-day requirements jumped 242.8 per cent.

Prime reason for this typical occurrence is the great, continuing swing to gas space heating. And indications are that this utilization can and will increase tremendously in the coming years.

At least one large utility has a heating saturation —that is, the percentage of gas heating customers to total residential gas customers—of very nearly 100 per cent. This is a good indication of the huge share of the heating market that can be captured by gas. However, a survey of utilities in 16 of the largest eastern and midwestern cities revealed an average heating saturation of only 56.7 per cent. While four had very good heating saturations, 84.9 to 89.3 per cent, two had very bad ones, 6.3 and 7.1 per cent.

Thus, peak-day requirements will continue to grow much faster than average day requirements, and peak shaving is going to be an increasing problem for distribution companies. Let's look at some of the aspects of that problem.

The per cent load factor determines what proportion of the total cost of doing business is created by the maximum demand. For a gas utility operating at 40 per cent load factor, this means that 40 per cent of its total capacity must not only support 100 per cent of its investment and operating charges, but also the demand charges on the unused 60 per cent of its capacity.

In the previously mentioned survey, half of the utilities supplied their maximum daily sendout figure, which is necessary to determine the load factor. The eight companies so replying had a heating saturation of 53.2 per cent and a load factor of 42.7 per cent. Thus, an average of 42.7 per cent of the facilities supported 100 per cent of the total costs.

How much of the total gas supply cost is contributed by peak-day supply costs? A formula establishes the exact percentage for any combination of load factor and rate:

$$K = \frac{1200\ Rd}{12\ Rd - 3.65\ L \times Rc}$$

K = per cent of total cost represented by demand cost.
Rd = demand rate, dollars per Mcf
Rc = commodity rate, dollars per Mcf
L = per cent load factor

Thus, for example, a distributing company with a 39.7 per cent load factor, buying natural gas at a $2.75 demand rate and a $.28 commodity rate, would find 45 per cent of its gas supply costs are demand charges.

If a company's demand is determined by increments, its load factor will vary inversely with the incremental units of demand above the minimum. The load factor on the last increment may then amount to 5 per cent or less and demand charges may amount to 90 per cent of the total gas costs.

Thus, in the upper increments of demand—where load factors are low and demand charges represent most of the total costs—some form of peak shaving is necessary. In such cases of high demand and short duration, it becomes feasible to use a peak-shaving gas which has a higher commodity charge and a lower demand rate.

Once the need for peak-shaving gas is established, the next step is to determine which of the five available types should be used and how it should be used. For modern, large-scale use, we rule out high-Btu oil gases, catalytically reformed hydrocarbons, and gasified coal. This leaves us a choice of either stored natural gas, or a propane-air mixture, which would use stored propane. Again, for large scale peak-shaving, we can in many cases rule out as financially impractical conventional aboveground storage of natural gas and propane.

This preliminary sifting leaves four possible peak-shaving solutions: natural gas, stored in either depleted sands or in liquefied form; and propane, stored in either salt domes or mined caverns.

Depleted sand storage of natural gas and salt dome storage of propane have limited application because each requires suitable geological formations, which usually are not present where needed.

However, where geologically feasible, underground storage of natural gas is undoubtedly the most economical peak-shaving method developed to date, especially for very large operations. Construction costs of this type of facility are so variable, depending on type, depth, and volume of the structure; number and condition of existing wells, etc., that a general cost estimate cannot be made. However, costs of some facilities have been as low as 40 cents per Mcf. It should be noted that part of the operating investment of this type of facility is the unrecoverable gas, which in some installations may be equal to the available net storage.

Again, where feasible, salt domes are the most economical method of storing propane. In some cases, their total cost is only 1 per cent of similarly sized aboveground storage. Where steel pressure tanks may run $30 to $50 per barrel, salt dome storage is only $.40 to $2 per bbl.

While basic patents covering liquefaction and storage of natural gas were granted in 1930 and the first American plant utilizing these principles was built in 1941, no natural gas liquefaction plants are now used for peak-shaving in this country. There is considerable talk about the future possibility of this method, however, and it may find limited use, particularly in areas geologically unsuited to underground storage of natural gas or propane.

Thus, for large scale peak-shaving one solution is left—a mixture using propane from mined underground caverns. Mined caverns have three different types of advantages: cost, safety, and product protection.

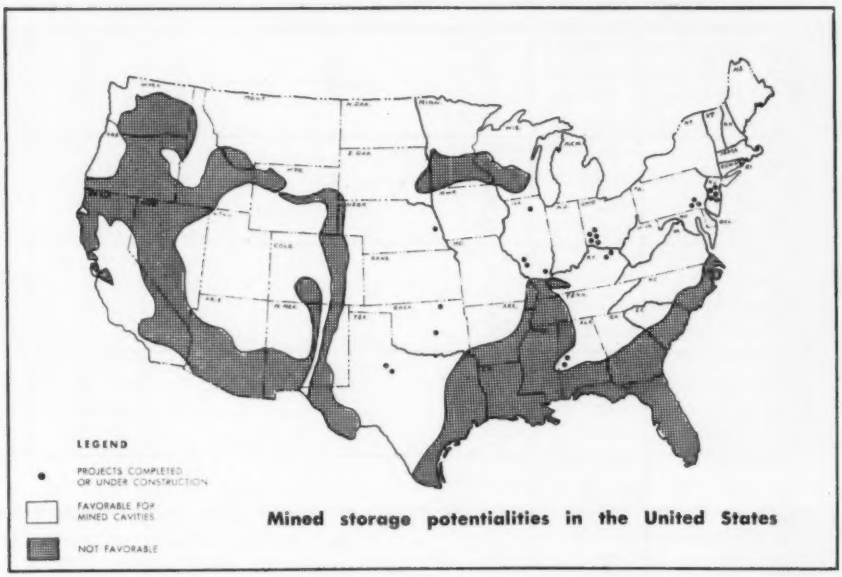
Actual costs of mined caverns vary considerably. Depending upon the characteristics of underground formation, labor conditions, and depth and size, mined caverns may be put into service for from $5 to $8.50 per barrel of capacity. Further economies come in operation and maintenance. The small amount of equipment above ground is readily accessible for periodic inspection and maintenance. The massive corrosion problems of aboveground steel tank storage become minimal. Also, of course, there is no refrigeration system to require fuel or service.

Safety—whether from natural or man-made dangers—is greatly enhanced. Because of the 300- to 700-ft depths of cavern storage, there is little danger of the product being ignited by lightning, tornadoes, cyclones, hurricanes or fire. It is estimated that a hydrogen bomb could hit within a few hundred feet of a mined cavern and cause no appreciable damage, whereas the same bomb could destroy surface tanks 20 miles away. Because of these factors, insurance rates on below ground storage are approximately half those of surface storage.

Product protection is assured not only because of the remoteness of outside influences, but also because mined caverns maintain a constant temperature and are very tight. It has been found that the more uniform underground temperature (usually 55 to 65) results in less deterioration than the aboveground storage. A National Petroleum Council survey found that operating losses ranged from 0 to 2 per cent for mined caverns, as opposed to 2 to 10 per cent for salt dome storage.

With these advantages, it is not hard to understand why mined cavern storage has—in a very short time—become tremendously popular with LPG producers. Just 10 years ago, Fenix & Scisson Inc., Tulsa, built the first such cavern—a small one of 20,000-bbl capacity for the Warren Petroleum Corp. Today, there are 29 mined LPG storage caverns in this country, totaling nearly 5 million bbl. Sizes now range up to 500,000 bbl. Of the 26 caverns mined by Fenix & Scisson, all but three are for producers, the exceptions being Cincinnati Gas & Electric Co., Dayton Power & Light Co., and the Metropolitan Utilities District of Omaha.

Most significant are two factors: (1) These 26 caverns have been mined in nine different states. And (2) 14 of them have been—or are being—completed last year and this year. The chances are good that both trends will accelerate even faster as the



Mined storage potentialities in the United States

use of mined caverns for LPG storage spreads, both numerically and geographically. As shown in the accompanying map, geologic formations suitable for underground storage caverns are found in 46 states.

Geologic considerations in selecting a suitable site for mined caverns are: depth and type of overburden, the amount of ground water, the water table, the physical and chemical characteristics of the rock, and the formation permeability. The suitability of the areas shown on the map has been determined by generally known geological characteristics, such as these listed by the National Petroleum Council:

- Sedimentary or crystalline formations lying below the coastal plain which is the central portion of the Atlantic Seaboard, from New Jersey to the Carolinas.
- Igneous rock in the long, narrow strip of granite, called the Appalachian Core, extending from Maine into Georgia and eastern Alabama.
- Shale or limestone in a folded belt of sedimentary rock lying west of the Appalachian Core.
- Sedimentary beds in the central states. (While a portion of this area, the Ozark Uplift, does not appear suitable because of mineral content, careful examination might lead to desirable locations.)
- A thick sedimentary formation in the Ozark Basin, south of the Ozark Uplift.
- Shale in the Permian Basin in west Texas.
- Shale beds in several sedimentary basins in the Rocky Mountain area, although this area generally is not satisfactory because of excessive faulting and fracturing of formation.
- Shale in several sedimentary basins in the Pacific Coast area, west of the Sierra Nevada and Cascade mountains.

It should be understood that these are all generalizations and actual field testing is required before an accurate determination can be made for a specific site. A feasibility study should be conducted by an organization with considerable experience in this field. Costing approximately $25,000, the study consists of seven operations:

1. Core to bedrock and obtain samples of overburden and bedrock.
2. Core to required depth.
3. Geological log of the cores, noting type, formation, joints, fractures, and faults.
4. Formation pressure testing.
5. Electric log of the holes.
6. Laboratory analysis of the cores.
   a. Permeability-to-air test.
   b. Porosity test.
   c. Permeability-to-propane test.
   d. Immersion-in-propane test.
   e. Immersion-in-water test.
   f. Compressive and tensile strength test.
   g. Specific gravity test.
7. Recommendations based on the preceding observations.

Those recommendations, of course, must be made with the nature of the product fully in mind. Propane is much less viscous than water and at ambient ground temperatures exerts a vapor pressure of 90 to 125 psig. It will go where water wouldn't think of going, and is hard to contain under any circumstances. The rock in which LPG is to be stored must be inert, impervious, massive enough to allow the excavation of a cavity, and structurally sound.

Extremely sensitive and reliable methods of testing formations through pressure tests at core holes have been developed. Proper interpretation of these tests, along with laboratory tests and visual examination of the cores, results in a reasonable evaluation of the suitability of the rock for storage.

Fracturing data obtained from oilfield practices indicate that generally a pressure in excess of 1 lb per ft of depth is required to fracture a formation. Stated

INVESTMENT AND PRODUCTION COSTS OF VARIOUS PEAK SHAVING METHODS
(Average Year)

	Natural Gas Pipeline				Utility-owned Liquefied Natural Gas				Utility-owned Propane Cavern & Mixing Plant			
Daily Capacity MMcfd	25	50	75	100	25	50	75	100	25	50	75	100
Average Annual Production, MMcf	18.3	62	172.5	390	18.3	62	172.5	390	18.3	62	172.5	390
Investment	---	--	---	---	$3,600,000	$5,400,000	$8,650,000	$11,900,000	$1,348,000	$2,655,000	$4,205,000	$6,570,000
Annual Fixed Cost or Demand ($) – 15% for Dep., Int., Taxes, Ins., Etc.	$ 825,000	$1,650,000	$2,475,000	$3,300,000	540,000	810,000	1,300,000	1,785,000	202,000	400,000	635,000	985,000
Annual Operating Cost ($) Feedstock, Oper. & Maint. .Labor & Materials	5,000	17,000	48,000	109,000	70,000	122,000	210,000	353,000	62,000	117,000	245,000	496,000
Total Annual Cost ($)	830,000	1,667,000	2,523,000	3,409,000	610,000	932,000	1,510,000	2,138,000	284,000	517,000	880,000	1,481,000
Savings Over Pipeline Use	---	---	---	---	220,000	735,000	1,013,000	1,271,000	546,000	1,150,000	1,643,000	1,928,000

Notes: Natural Gas Demand Rate $2.75/Mcf/month
Natural Gas Commodity Rate $0.28/Mcf
Propane @ $.08 1 gallon
Annual Liq. Nat. Oper. & Maint. $60,000, $90,000, $120,000 and $150,000
Liquefaction – $.25/Mcf

OPPOSITE: Fig. 1. Investment and production costs of various peak shaving methods.

in another way, the pressure exerted in the cavern would have to exceed the weight of the overburden before fracturing. Therefore, by industry agreement, a minimum depth of 1 ft per lb of anticipated operating pressure was established as the industry standard. As a general rule, caverns operate at less than 150 psig, but a minimum depth of 200 ft has been adhered to.

It is common practice to locate caverns at sufficient depth—300 ft—below the existing water table to cause (at the cavern level) a hydrostatic pressure that will be greater than the pressure of the product stored. Thus, any leaking would be water into rather than out of the cavern.

Construction of mined caverns follows certain established-through-experience techniques. GAS Magazine readers will recall the detailed description of these techniques in "Cincinnati goes underground with LPG" in the December 1959 issue. While thorough, the article covered just one particular installation and more general construction information should be of genuine service to the reader.

Location of the main shaft is governed by existing surface structures. Maximum operating area on the surface should be provided for efficient operations. Depending upon local conditions, shafts may be sunk by conventional drill-and-blast methods or by rotary drilling or coring. Small diameter shafts are also required—for ventilation initially, but later for pumping the product. Because of their size, they are either cored or drilled. All shafts are lined with casings, which are grouted in place.

Mining operations follow the general practices of the room-and-pillar method with several adaptations to achieve the efficiency needed when the only contact to the outside world as a 42-in. shaft. Loaders and tractors are completely disassembled, lowered into the cavern, and re-assembled down below.

Actual design of the cavern depends upon the rock formation. In shale, about 35 per cent of the material is excavated, leaving the remaining 65 per cent in place to act as natural support. In granite, the figures may be reversed, with only 35 per cent left to hold up the ceiling of the cavern. The height of the cavern also depends upon the rock, varying from 20 to 30 ft for shale to 40 ft for granite.

Since it is impossible to predict all variations in formation, the underground operation must be flexible. Unforeseen faults, fractures, or changes may be encountered during construction. After studying the problem, adjustments must be decided upon.

Upon completion of mining operations, sumps are sunk below pump shafts which are deep enough to provide adequate water seal. Casing is extended from the ventilation holes to within a few feet of the bottom of the sump. A vertical deep-well pump column is inserted inside the casing. By flooding the sump and casing with sufficient water, a seal is provided, acting the same way as a water manometer. Then, the pump may be repaired while the cavern is in use.

The floor of the cavern is usually graded to the sumps and may be packed hard, or a light coating of cement may be raked in. Equipment is removed from the cavern, the fill lines, pumps, and gauges are installed, and the permanent head is welded on the main shaft.

Then, an air pressure test is made, the pressure slowly building up to exceed maximum operating pressure, which is held for a prescribed time. At hourly intervals, pressure and temperature readings are taken. If the pressure test is satisfactory, the cavern may be immediately put into operation.

While a Christmas tree manifold with input and output water lines is needed to inject and recover product from salt cavities, a mined cavern is relatively simple to operate. Cavern-users either inject the product directly from the processing unit or use a conventional pump. Injection is accomplished by dumping the product into the top of the shaft and letting it fall down, or by extending the fill line into the cavern and distributing the product via a spray bar header or similar arrangement. Generally, compressors are in the minority for product withdrawal, most caverns utilizing either submersible or deep-well type pumps.

Operating losses generally are negligible. The usual practice is to remove only the liquid, which leaves a perpetual vapor inventory. During the first filling operation, there is a waste of less than one-half per cent in purging the cavern. After this, the cavern should normally be filled and emptied with negligible operating losses, about identical to those for comparable aboveground storage.

With a general idea of the advantages and possibilities of underground storage, you may now be wondering "What does it all cost?" As indicated earlier, costs vary according to labor rates, plant facilities available, size of the cavern, geologic conditions encountered, and many other factors.

Plant facilities include terminal installations, dehydrators, fractionators, loading racks, land, etc. Most of these items vary considerably from place to place. However, the cost of the cavern itself—excluding land and plant—can be approximated.

Some of the costs are independent of cavern capacity; geologic evaluation and testing, sinking and lining the shaft, drilling and equipment product handling wells, and installing pipes, valves, meters, and other miscellaneous items. On the average, these add up to $350,000. We figure them like this: geological studies and testing, $25,000; mine shaft, including sealing, $100,000; auxiliary drilled holes, piping, etc., $100,000; pumps, valves, gauges, and similar equipment, $75,000; and mine development, $50,000.

The actual excavation cost is a variable largely dependent upon the labor cost in the area, depth of cavern and rock formation. For illustrative purposes, we can assume that excavation costs will be $3 per bbl. Thus, for a 100,000-bbl capacity cavern, excavation costs would be $300,000. Adding this to the fixed cost of $350,000, we get a total of $650,000, or $6.50 per bbl. Using the same excavation cost per barrel and the same fixed costs, we find that costs for larger caverns look like this:

Size of Cavern	*Total Cost*	*Cost per bbl*
200,000 bbl	$ 950,000	$4.75 bbl
300,000 bbl	$1,250,000	$4.17 bbl
400,000 bbl	$1,550,000	$3.88 bbl
500,000 bbl	$1,850,000	$3.70 bbl

Actual costs for completed projects have varied from just under $3 per bbl to just over $7.50.

A company planning to mine a cavern should be prepared for contingencies that might require as much as an additional $100,000 to make the cavern useful. Such contingencies are all normal to underground construction and mining, and usually involve unknown rock structures, indeterminable quantities of ground water, and the possibility of geological changes.

Isolated cost figures are not particularly illuminating. Therefore, let's consider the case of a hypothetical utility faced with a peak-shaving problem. Its present annual demand is 50 billion cu ft with a maximum daily demand of 400 MMcf. Of its 90,000 customers, 80,000 are residential with a 60 per cent heating saturation. Within two years, the company expects to add 10,000 residential customers, upping its heating saturation to 70 per cent and its annual demand to 58 billion cu ft. However, the design maximum daily sendout of its supplying transmission company remains 400 MMcf.

The company has three alternatives: (1) Buy the natural gas as it needs it during the peak season and pay the demand rate. (2) Buy peak-shaving natural gas during off-peak periods and store it in refrigerated aboveground storage, if there are no depleted gas sands anywhere in the area. Or (3) invest in a propane-air plant and a mined underground cavern, if favorable geological conditions are believed to exist.

While the figures used in determining the various costs of the alternatives are purely imaginary, they are realistic "averages." In *Fig. 1*, cost figures are shown for each of the three alternatives, and in each case, four sets of figures are given showing what the utility would have to spend to boost its daily capacity by anywhere from 25 to 100 MMcf.

Should the company decide to raise its daily capacity 25 MMcf, it would save $220,000 annually by putting up its own liquefied natural gas plant, but this figure would jump to $546,000, if it set up a mined-cavern-supplied propane-air plant. The mined-cavern, propane-air plant would, as a matter of fact, pay for more than 40 per cent of itself in one year.

The savings increase almost proportionally as the size of the propane-air plant increases. Thus, a 100-MMcfd plant would net annual savings of nearly $2 million, as shown in *Fig. 1*. That is nearly two-thirds million dollars more than a liquefied natural gas plant of similar output would save.

What would be needed to bring about such large savings? It would take a $6,570,000 investment, which is itemized in *Fig. 2*. The vast majority of this investment would be divided into three approximately equal parts: $2.26 million for the 605,000-bbl cavern, $2.12 million for the plant, and $2.03 million for the inventory of propane. Note, however, that only in the largest installation does the cavern become the most expensive cost item and do the three items come close, cost-wise. In the 25-MMcfd installation, for example, the cavern is less than half the price of the plant, and the propane inventory, in turn, is less than half the cost of the cavern.

The land and equipment requirements needed for four different sizes of propane-air installations are shown in *Fig. 3*. Note that a 25-MMcfd installation needs only a 50,000-bbl cavern and an annual propane inventory of $168,000 while a 100-MMcfd installation requires a 605,000-bbl cavern and an annual propane inventory of $2,030,000.

Since time and money are closely related, the time involved becomes important. An average, 200,000-bbl

Investments Required for Various Sizes of Typical Propane Caverns & Mixing Plants

Daily Capacity, MMcfd	25	50	75	100
Land	$ 60,000	$ 60,000	$ 60,000	$ 80,000
Plant	720,000	1,250,000	1,600,000	2,125,000
Cavern	350,000	775,000	1,340,000	2,260,000
Inventory (Propane)	168,000	520,000	1,130,000	2,030,000
Cash	50,000	50,000	75,000	75,000
Total Investment	**$1,348,000**	**$2,655,000**	**$4,205,000**	**$6,570,000**

FIGURE 2.

Land & Equipment Required for Various Sizes of Typical Propane Caverns & Mixing Plants

Daily Capacity, MMcfd	25	50	75	100
Land	30 ac.	30 ac.	30 ac.	40 ac.
Cavern Size	50,000 bbl	155,000 bbl	235,000 bbl	605,000 bbl
Deep Well Pumps				
Number	2	2	4	4
Capacity	300 gpm	550 gpm	300 gpm	550 gpm
Above Ground Purge Tanks				
Number	1	1	2	2
Capacity	15,000 gal.	30,000 gal.	24,000 gal.	30,000 gal.
Boilers				
Number	2	2	3	4
Steam Capacity	9,000 lb/hr	17,500 lb/hr	17,500 lb/hr	17,500 lb/hr
Vaporizers				
Number	2	2	3	4
Capacity	8 MM Btu/hr	15 MM Btu/hr	15 MM Btu/hr	15 MM Btu/hr
Compressors				
Number	2	2	3	4
Capacity	825 bhp	1650 bhp	1650 bhp	1650 bhp

Figure 3.

cavern will require about 19 months from the decision to initiate preliminary studies until the unit is placed in operation. The actual mining itself, however, takes only about seven months. Here is a typical timetable for a 200,000-bbl cavern: preliminary studies, 1 month; site selection and land option, 2 months; site investigation, including core drilling, establishing basic design for the particular site, and probable cost, 3 months; detailed design, 1 month; construction of mine shaft, 4 months; mining, 7 months; and testing and placing in operation, 1 month.

All cost figures are based on a utility-owned propane-air plant. Many companies might find it to their advantage to have an independent company furnish them the mixture on a demand and commodity rate. Possible advantages to such an arrangement are: (1) No additional capital tied up in construction and inventory which could be available to promote or extend the system. (2) No involvement in an unfamiliar type of project and little risk to the utility since every underground project *does* constitute a delving into the unknown. (3) The savings effect in reduced pipeline demand charges would be immediately reflected in earnings without first being used to pay off an additional indebtedness. And (4) under present conditions, there isn't an attractive spread between the cost of borrowing money and a utility's regulated profit.

Fenix & Scisson, for one, offers not only to engineer and construct mined caverns and the associated propane-air plants, but also to set up affiliated or associated companies to install the required facilities and sell the propane-air mix to utilities. Contracts, similar to those between natural gas transmission companies and utilities, are used.

To sum up, then, we believe mined cavern stored propane offers at least five big advantages:

- 1. Substantial savings over all other systems except those which rely on geological oddities, that is, depleted sands for natural gas storage and salt domes for propane storage.
- 2. The chances are good that cavern storage can be developed at the most desirable location.
- 3. The cavern may be designed to fit the actual needs of the system, rather than having to adapt it to fit the needs.
- 4. Cavern storage can be unloaded at a very high rate, not being limited by physical characteristics, are as depleted sands.
- 5. A very small volume of cushion gas is required.

Whether they have no peak-shaving facilities, or whether their present peak-shaving facilities are obsolete or inadequate, many distribution companies should find mined-cavern-stored propane economic and otherwise attractive. This should hold whether they own the cavern and plant or whether they buy the propane-air mix from an independent company which has the cavern and plant. ■

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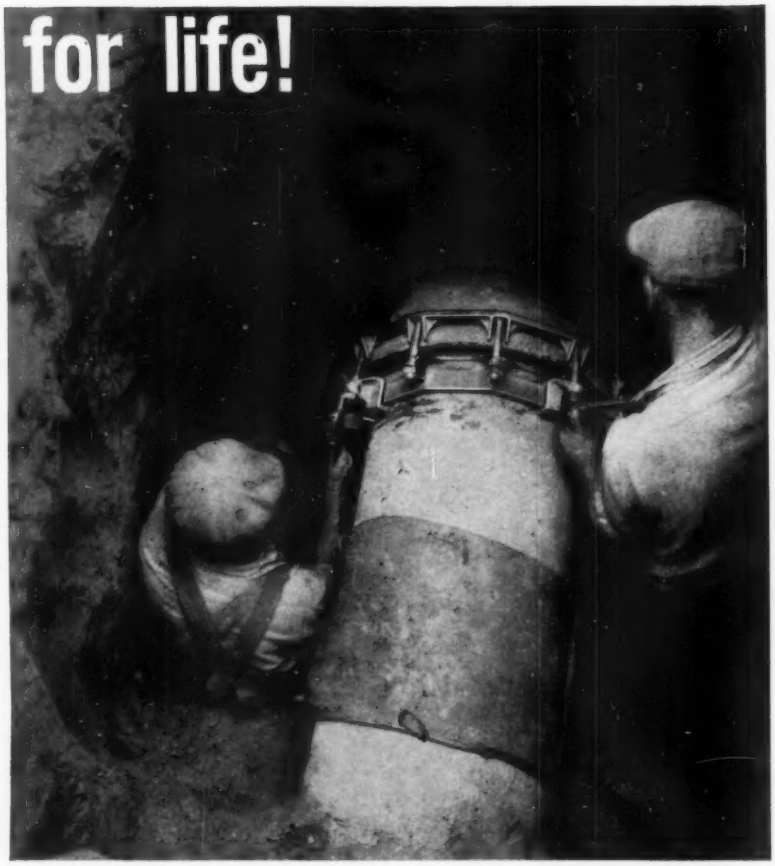

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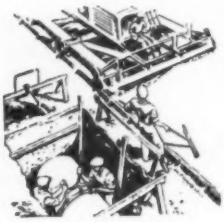

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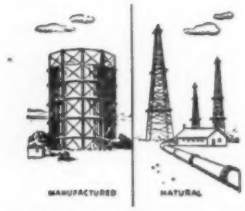
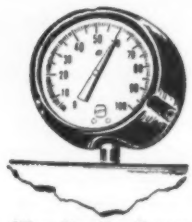
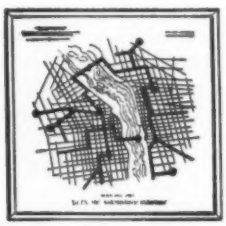


When Switching from Wet to Dry Gas



When Boosting Pressure



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GEORGE S. YOUNG is the newly elected chairman of the board and chief executive officer of Columbia Gas System Inc. CECIL E. LOOMIS succeeds Young as president. Young began his gas career in 1930 when he joined Columbia Engineering & Management Corp. as a junior engineer. In 1942 he went to New York as vice president of what is now known as Columbia Gas System Service Corp. In 1946, Young became a director of the parent corporation and vice president in charge of operations for the Service Corp. In 1949, he was elected executive vice president of Columbia Gas System; two years later he became the parent company's president. Loomis has spent virtually all of his business career with Columbia, joining up in 1928 in Columbus, Ohio. In 1950 he became assistant vice president of Columbia as chief aide to Young. He became vice president in 1951, and subsequently senior vice president.

Officers elected at Greenwich (Conn.) Gas Co. include FREDERIC L. PUTNAM, chairman of the board; DAVID T. GILBERT, president; WILBUR B. ABRAMS, vice president, distribution; RICHARD A. WINSLOW, vice president, sales; WALTER E. SWANSON, treasurer; and GARDNER L. BRISTOL, secretary.

WALTER C. SCHMIDT has been elected a vice president of Consumers Power Co., Jackson, Mich. He was formerly manager of engineering and construction. ROBERT D. ALLEN, formerly coordinator of consulting engineering services, was elected assistant to the president.

FRED W. BATTEN has been named vice president and chief operations officer of Columbia Gas System Inc., New York. Batten, with Columbia since 1936, most recently has been vice president of the Service Corp. In his new post, he is responsible for the system's production, transmission and distribution of natural gas, and the extraction of heavier hydrocarbons from natural gas streams.

Bonney Forge & Tool Works, Allentown, Pa., elected four vice presidents recently. They are: GEORGE D. FRITCH; WILLIAM M. JACKSON, vice president and division manager of the Bonney Forge division; RICHARD R. HOLSTROM, vice president and division manager of the tool division; and GEORGE A. HART, vice president and general sales manager.

ROBERT H. BURGAN JR. has been named Mid-Atlantic regional manager by Davey Compressor Co., Kent, Ohio. Headquartered in Baltimore, Burgan covers Maryland, Virginia, Delaware, southeastern Pennsylvania, and southern New Jersey.

Continued on page 84

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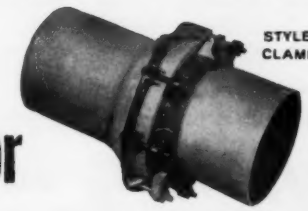

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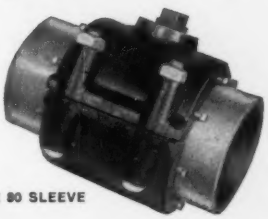

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GAS DISTRIBUTION NEWS

RCA to lease radio service to southern California companies

Radio Corp. of America will assume ownership and maintenance of radio communications systems for Southern California and Southern Counties Gas companies. The move will take place this summer if needed regulatory approvals are obtained.

In 1955, the two big California integrated gas companies—operating subsidiaries of Pacific Lighting Corp., San Francisco — sold their systems to Pacific Telephone & Telegraph Co. and entered a lease-maintenance agreement with that firm for radio communications service. Another Pacific Lighting Corp. subsidiary, Pacific Lighting Gas Supply, did not integrate its radio system into this arrangement.

This year, Pacific Tel & Tel, along with other AT&T affiliates, announced its intention to withdraw from the field of leasing and maintaining private radio systems.

Now, SoCal and SoCounties propose to buy back the fixed radio stations from PT&T and resell them to RCA. The gas companies will, however, retain title to buildings, towers, and generators, selling only the actual communications gear to RCA.

Mobile units will be exchanged for new transistorized RCA equipment. Changeout of mobile equipment is expected to be completed this summer.

Service will be provided to the Los Angeles-based companies by RCA on a lease-maintenance basis.

The two gas companies are currently served by: 31 base stations (16 SoCal, 15 SoCounties); 5 remote-control relay stations (SoCounties); and 540 mobile units (465 SoCal, 75 SoCounties).

United Gas forms manufacturing division

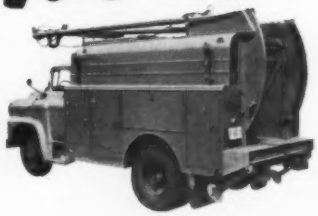
United Gas Corp., Shreveport, has set up a new manufacturing and marketing division, according to word from Ed Parkes, president. The UGC Instruments division, headed by Director of Research D. T. MacRoberts, is an outgrowth of the company's research and development program.

The manual, time-consuming method of reading meters and charts and of calculating and recording the results has received the concentrated attention of United's researchers. Now they have developed three pieces of equipment that will materially reduce man-hours required by the gas industry in measuring the volumes of gas sold to each customer. They are (1) an electronic chart reader, (2) a linear chart averager, and (3) a miniature tape recorder to be used by meter readers.

(Detailed descriptions of these developments were published in two articles in the April and May issues of GAS. The articles were "The Changing Face of Meter Reading, Data Processing, and Billing," by Edwin D. Nuttall, April, pp 43-48, and "United Develops Easy-to-Operate Orifice Meter Chart Scanner and Computer," by D. F. Searcy, May, pp 132-136.)

Other instruments developed by United's research department, all of which will be manufactured and marketed by the UGC Instruments division, are: pipeline calipers, designed to operate in pipelines up to 36 in. in diameter; automatic relighters for oil and gas field heaters; and an improved dew-point detector.

Koenig ALL-STEEL UTILITY BODIES



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Mr. John W. Kelley (seated) President of Columbia Gulf Transmission Co., Houston, and Mr. S. Orlofsky, Vice President, examine model of Clark TPV gas engine now installed in their Hampshire, Tennessee compressor station.

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The Nation's ever-growing need for natural gas means that the present gas network will be increased from 596,000 to 878,000 miles within ten years. By creating the powerful TPV gas engine, Clark Bros. Co., one of the Dresser Industries, is helping pipeline companies to deliver gas at minimum cost to consumers.

Combining two-cycle simplicity and dependability with V-type compactness and efficiency, the new Clark TPV engine provides savings in installation, housing and operating costs. It is another dramatic innovation made possible by the vast knowledge and experience of Clark engineers whose "precision by the ton" products include heavy-duty gas turbines and compressors as well as engines.

At Clark Bros. Co., Olean, New York, as with all Dresser operating companies, new products are continually being researched, developed, tested and introduced. Individually, in combination, or as a complete group, Dresser companies are prepared to put their specialized yet diversified skills and worldwide facilities to work for you.

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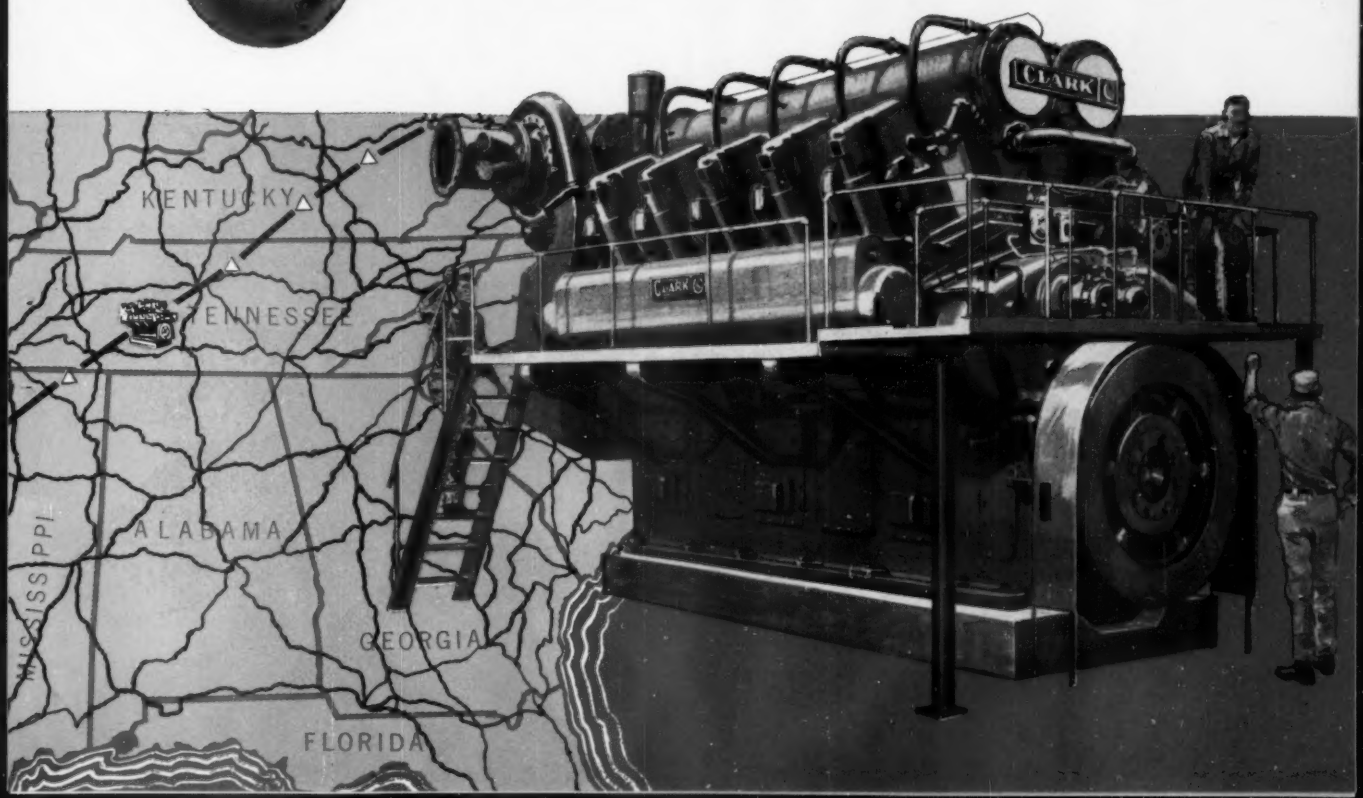


AGA sees 57.5 million appliances sold by '65

Nearly 57.5 million gas appliances can be sold during the next five years. The figure is contained in AGA's summary of its analysis of residential market potentials.

With increased product development and sales promotion, sales can exceed those of 1955-1959 by 14.8 million units.

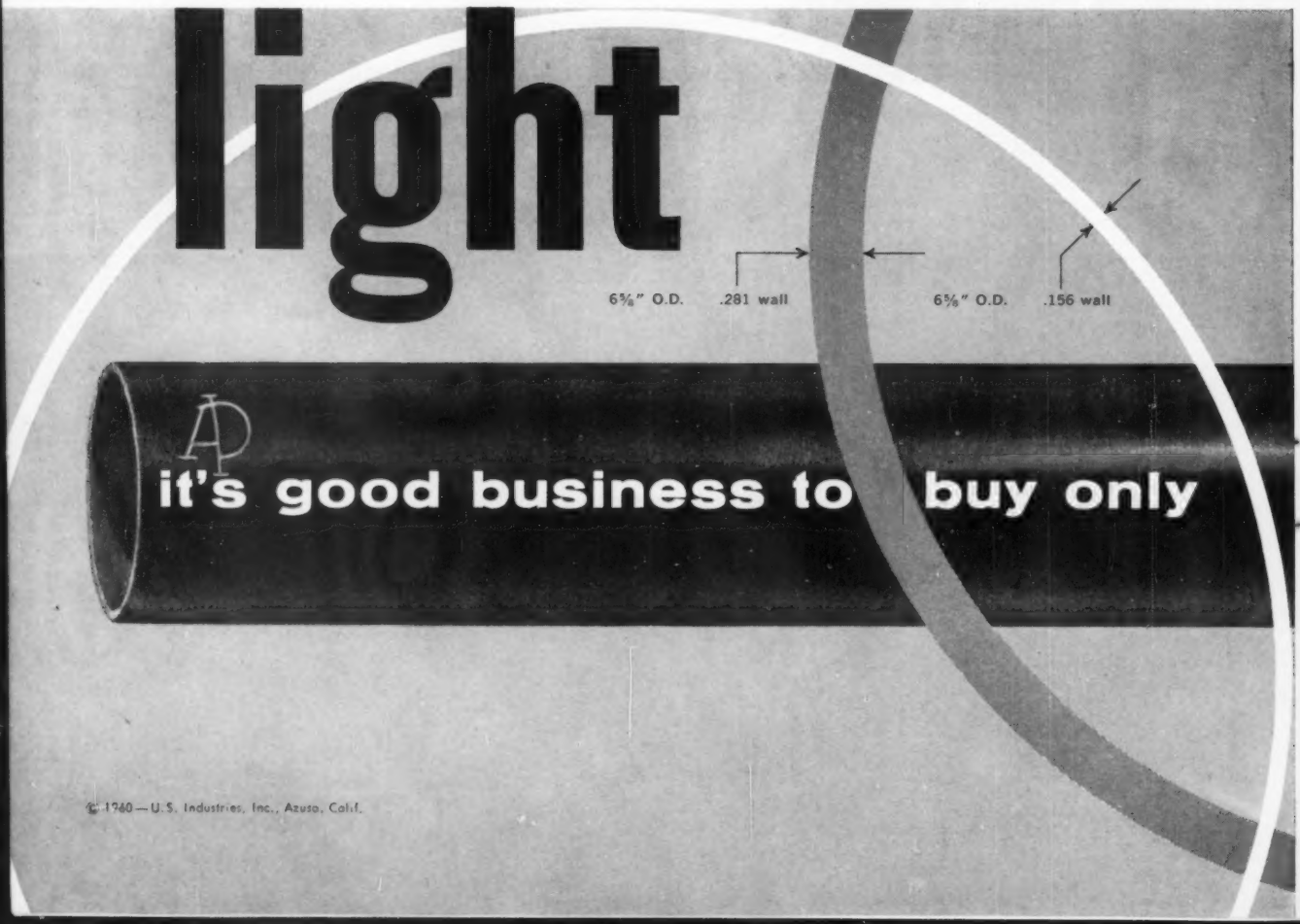
Here is how it breaks down for the period ending in 1964: 18 million water heaters, 13.3 million ranges, 10.1 million space heaters, 7.4 million central heating units. Also, 5 million clothes dryers, 3.3 million floor and wall furnaces, 300,000 gas incinerators.

Half of the potential—28.7 million—represents replacements. In addition, 21.6 million appliances are for new homes or existing homes not using gas for the specific purpose involved. And, 7.1 million units would replace competitive equipment.

AGA statisticians used projections of residential construction rates, acceptance of gas appliances in new housing, the number of gas and competitive appliances now in use, and their ages and individual rates of replacement. Everything was taken into consideration, including the effects of the 1959 steel strike, growth patterns of newer gas appliances, and the demand for added heating units in homes not served by central heating.

Telling the story

A "packaged" story of an appliance maker's line was told recently to Northern Illinois Gas Co.'s new building department. A half-day, coordinated merchandising and sales program was conducted jointly by NI-Gas and Norge in Chicago. The program was handled by Harry C. Schneider, manager of NI-Gas new building sales, and Norge's Frank Coyle, manager of builder sales, and E. A. Nash, director of utility sales. More than 40 attended.



Industry stores 2 trillion cu ft

Nearly 2 trillion cu ft of natural gas was in underground storage in 1959. According to the AGA announcement, this is an all-time, year-end high.

The industry now has spent nearly $700 million on underground storage.

Lysle R. Kirk, chairman of AGA's subcommittee on underground storage statistics, made his report at the AGA's combined distribution and transmission conference. He said that utilities and pipelines had 1901 billion cu ft of natural gas in storage on Dec. 31, 1959. This compared with 1763 billion a year earlier. In 1950, we had 342 billion cu ft.

Four states—Pennsylvania, Ohio, West Virginia, and Michigan—account for more than two-thirds of the total gas in storage.

In 1959, there were 20 states with 209 storage pools and 8512 active wells, compared with 1958, when 19 states had 205 pools and 8237 wells.

The accompanying table presents statistics on state-by-state storage.

Basic Underground Storage Statistics by State, 1959

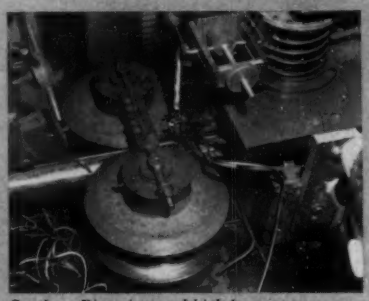
(Mcf—14.65 psi at 60°F.)

State	Total Reservoir Capacity (Mcf) 12-31-59	Total Gas in Storage Reservoirs (Mcf) 12-31-59
Arkansas	5,204,421	4,831,380
California	99,038,182	91,018,495
Colorado	186,700	164,300
Illinois	45,915,003	45,139,843
Indiana	12,453,884	10,252,889
Iowa	49,893,534	46,400,782
Kansas	83,623,223	62,701,969
Kentucky	27,264,569	24,193,057
Michigan	397,498,020	285,259,436
Mississippi	7,056,540	5,538,015
Missouri	9,716,585	9,717,981
Montana	87,075,505	41,057,336
New Mexico	77,871,510	47,741,478
New York	65,231,688	57,559,840
Ohio	433,515,740	336,765,639
Oklahoma	179,977,245	105,616,828
Pennsylvania	496,848,519	404,256,411
Texas	50,686,975	44,263,737
West Virginia	328,523,941	258,294,482
Wyoming	62,971,840	20,424,205
	2,520,553,624	1,901,198,103

specify LITE-WALL save as much as 33%

Approximately $365,000 in pipeline cost was saved by specifying and buying Southern Pipe LITE-WALL pipe. (Company name on request.) The job called for a 147-mile, 6⅝" petroleum products line. LITE-WALL pipe cut cost by more than ⅓.

It's good business to buy only the steel necessary to do the job. In many cases you needn't buy heavy wall pipe, when Southern's LITE-WALL pipe—available from factory stock—will meet your requirements and afford an ample safety factor.



Southern Pipe pioneered high frequency resistance welding in pipe production.

Southern Pipe offers oil and gas pipe buyers LITE-WALL pipe to cut cost. They also produce line pipe according to API specifications. Sizes range from 3" to 14". Interior and exterior coatings are also available.

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SP-6-60

Gas hit of Houston show — again

Natural gas dominated the Houston Parade of Homes for the third consecutive year.

In 16 of the 31 Parade homes gas air conditioners and other gas equipment were shown in actual use. In each of the 16 all-gas homes gas lights illuminated outdoor living areas. In many of the homes, gas rotisseries and open broilers were features of patios and poolside terraces.

A home service girl of one of the Houston gas companies is shown at her post in one of the 16 all-gas homes which highlighted the 1960 Parade of Homes.

The two-week show is sponsored by the Houston Home Builders Association.

The two Houston gas distribution firms, United Gas Corp. and Houston Natural Gas Corp., collaborated with gas equipment manufacturers. They displayed gas refrigerators, cooking and laundry equipment, gas water heaters, lights, air conditioners, in a colorful 3600-sq ft display in the Home Show, which adjoins the Parade of Homes.

Emphasizing the importance of the event—the largest show of its kind in the South — both RCA Whirlpool and Norge rushed first models of their new gas refrigerators off the assembly lines and into the exhibit and model homes.

Representatives of United and Houston Natural staff all 16 of the "all-modern, all-gas Blue Star Homes."

The gas equipment exhibit was the largest in the Home Show and dominated the exhibit tent.

More than 175,000 visitors attended the combination Parade of Homes and Home Show during its 15-day run.

Fisher holds conference

Over 60 operating and supervisory gasmen attended Fisher Governor Co.'s spring gas conference. Visitors to the Marshalltown, Iowa school came from every section of the U. S., eastern Canada, and one from England. Topics included design, production, and application of gas regulators and controllers.

℞ FOR SURE PROTECTION

You've made a worthwhile investment in this pipe. You've spent some more on cleaning and coating. Why risk the cost of digging it up in a few years to repair corrosion damage?

With ERP protection you won't need to. Electro Rust-Proofing takes care of those pinpoints of corrosion that even the best coating cannot prevent. When your pipeline is laid, ERP makes a test survey to determine your needs. Once cathodic protection is installed, a periodic service visit by ERP engineers keeps your pipeline new—for good. They adjust your protection as your needs or environmental conditions vary.

ERP installs corrosion protection anywhere . . . at any time. But your greatest savings come if you call ERP early . . . if you plan your protection while you plan your pipeline. Write ERP today—Dept. E.55.41.

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CABLE: ELECTRO, NEWARK, N. J.

LIGHT WEIGHT AMERICAN® ALUMINUMCASE METERS

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- **Dependable and economical.**
- **Light weight and rugged.**
- **Modern and attractive—assures customer acceptance.**
- **Sustained accuracy at lowest cost.**

AMERICAN AL-175

Rated at 175 cfh, the AL-175 is American's latest model to provide a complete line of domestic aluminumcase meters . . . for most domestic services.

AMERICAN 5B-225

Rated at 225 cfh, operates at the conventional nine revolutions per cubic foot and is comparable with the standard 5B Ironcase meter . . . for medium-sized domestic loads.

AMERICAN AL-250

Rated at 250 cfh, operates at only 7 revolutions per cubic foot for sustained accuracy through greater power and slow-speed operation . . . for home heating and small commercial loads.

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GENERAL PRODUCTS DIVISION
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Thermoelectric generator delivers 5000 watts

What is believed to be the most powerful thermoelectric generator ever built has been announced by Westinghouse Electric Corp.

The generator delivers 5 kilowatts (5000 watts) of electric power by direct conversion, without major moving parts, of heat into electricity. It is 50 times more powerful than any previously described thermoelectric power plant. It delivers enough power to brightly light eight to 10 average homes simultaneously.

Westinghouse developed the generator for the Bureau of Ships, U. S. Navy. The experimental unit is for evaluation of power-generating materials and fabrication techniques which have been produced under a Navy-sponsored thermoelectric materials research program.

To secure maximum flexibility in design, the new generator is built up from thermoelectric assemblies, or modules. These can be arranged electrically to give a wide range of output voltages and currents. Combinations range from 10 v at 500 amp to 120 v at about 42 amp.

This modular construction also gives versatility in physical design, permitting the generator to be built as two identical "sub-generators" which are connected together to give full power output, or used independently of one another as separate 2500-w power plants.

The only moving parts in the entire 5000-w unit are those in the pumps for the cooling water and for the kerosene fuel burners. Both are operated by electric motors which receive their power from the electrical output of the generator itself.

Westinghouse believes that where it would be economically feasible, this generator could supply the entire electrical requirements of a campsite or some inhabited outpost in a remote area. Or it could power a rather impressive array of electronic or electrical apparatus.

Columbia U. producing gas from coal

Columbia University's laboratory for producing gas from coal made its public debut recently.

Made of concrete blocks, the structure is a cube, 22 ft high. Soon, the blockhouse will contain enough radioactive cobalt 60 to emit gamma rays producing up to 1 million roentgens an hour.

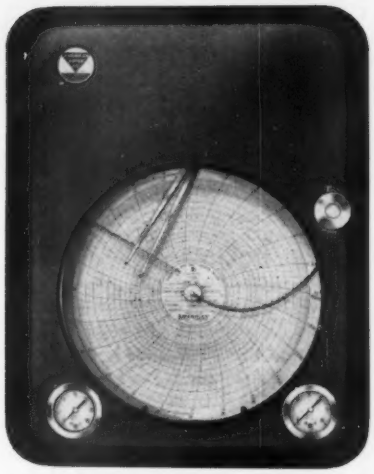
Coal, or such derivatives as coal char, will be bombarded by radiation from the cobalt. Among gases produced by the bombardment will be natural gas' chief ingredient—methane.

The project is aimed at cheaper production than well drilling. Financial backing is from Consolidated Natural Gas system.

Major expansion

Kraloy Plastic Pipe Co. has opened new general offices and manufacturing facilities in Santa Ana, Calif. Kraloy also opened a new district office and warehouse in Dallas. The Santa Ana plant gives the company one of the largest plastics extrusion facilities in the country. Vice President Russell W. Johnson said the new facilities are only the nucleus of a nationwide expansion program.

AMERICAN®



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A-88
CONTROLLERS

Designed to give rugged, dependable performance, Series A-88 Controllers provide versatile, positive control of . . . Flow, Pressure, Liquid Level and other continuous process variables . . . accurately and automatically.

- Rugged, null-type non-bleed Relay.
- Simple, in-the-field linkage adjustment.
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- Proportional Band easily widened without disconnecting instrument tubing.
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Ask for Bulletin CT-49.

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General Offices: Philadelphia 16, Pa.
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Late battle reports from the Miami gas "war"

Like daily reports from the battle field, come stories of skirmishes in the intermittent battle between various Miami groups and the Houston Corp. With the Miami Junior Chamber of Commerce promised a chance to present its case against the big integrated company at a July 28 hearing, all had seemed quiet on the Florida front.

Then, on May 24, the Miami JCC charged that the Florida JCC had undermined its efforts by recently accepting a $20,000 gift from the Houston Corp. The gift was to be spent for a statewide community development program, which—the Miami chamber contended — was not needed.

At the same time, the Miami Jaycees charged Houston Corp. was being investigated by state attorneys for "allegedly perpetrating voting frauds" in the May primary election.

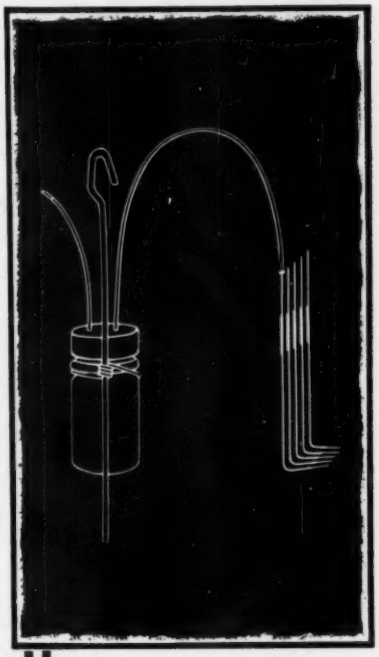
On May 26, a state attorney said there was insufficient evidence to charge the company with violation of election laws for allegedly allowing its bill-addressing machine to be used to address political literature.

That same day, the president of the Florida JCC charged that the Miami chapter was hunting headlines. He cited the fact that the Miami JCC president — who had been quoted in the charges two days earlier—not only attended the state meeting at which the gift was accepted, but "personally assured" the state president that the agreement was "in the best interests of the local clubs."

On May 27, Houston Corp. dropped its own little small bombshell to end the explosive week. One of its subsidiaries, which pipes the gas into Florida, applied for a 7.27 per cent rate increase. The application said present rates were based on pre-construction estimates, which proved 14 per cent low. Complaints from the Jaycees and the City Commission were as immediate as could be expected. New charges were leveled that the company was "attempting to cloud the coming hearing" and was "violating every statement it made when it got permission to come here."

The verbal guns were quiet until June 10, when the Florida PUC filed a protest to the "unjustly discriminatory" rate rise.

CANNON
PENS



UP TO A YEAR
WITHOUT REFILLING

Cannon Meter Pens are easily installed as original or replacement equipment in all standard recording instruments. Produce accurate charts of maximum legibility. No blurring or smearing.

- Ends unrecorded intervals. Unaffected by pulsating flows, chart speeds, or rapid pen movement.
- Sealed ink supply prevents clogging from atmospheric contamination.
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- Available in five sizes and angles. Special pens designed to customer specifications on request.

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60th anniversary

Canadian Meter Co.'s 60th anniversary was celebrated recently when Canadian gas industry leaders and American Meter Co. officials joined to honor the company. Among guests at a luncheon given by John W. Ostler (left), president of Canadian Meter, were W. H. Dalton (center), managing director of the Canadian Gas Association, and William G. Hamilton, president of American Meter.

Utility financing up in 1st quarter

Financing activities of the nation's privately owned public utilities were stepped up in the first quarter of 1960.

During that period, utilities raised $959.9 million, 10 per cent more than the $870.9 million of financing during the 1959 period.

Gas company financing was up $97.1 million. Top increase was in telephone company financing, with $139.9 million. Electric utilities dropped by $127.9 million.

N. Y. Natural wins 2nd safety award

Half a million manhours without a lost-time accident have been recorded by New York State Natural Gas Corp.'s Oakford station. The plant received a National Safety Council certificate of commendation for its safety record which stretches over a 5-year period.

Oakford is the second New York Natural installation to win the certificate. Preston, at Sycamore, Pa., received the award last year.

Utilities fight interruptible case

Illinois Commerce Commission was asked to dismiss a move aimed at halting the sale of gas as an interruptible boiler fuel. The complaint was brought by various coal interests. Peoples Gas Light & Coke Co. and Northern Illinois Gas Co. asked for the dismissal.

Coal interests allege that rates charged for this service are "fixed at a price below coal," adversely affecting coal sales. Peoples Gas says rates for interruptible service are higher than incremental cost of providing service and below price of competitive fuels in accord with a 1953 ruling by the Illinois supreme court.

If Peoples Gas could not dispose of surplus gas to interruptible boiler fuel users, the loss in revenue would have to be made up by charging residential, commercial, and industrial customers more.

Utilities ads win recognition

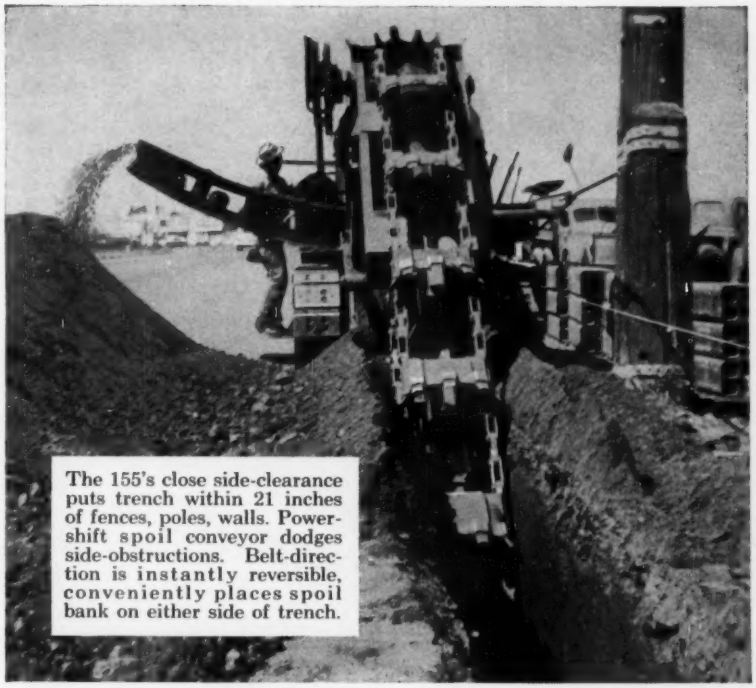
Ninety-four utilities won outstanding honors in the field of advertising. Award certificates were presented to the winners by the Public Utilities Advertising Association. In all, 165 awards were made in 21 classifications.

Washington Water Power Co., Spokane, won five awards. Six companies won four awards each. Among these were: Northern States Power Co., Minneapolis; Philadelphia (Pa.) Electric Co.; South Atlantic Gas Co., Savannah, Ga.; B. C. Electric Co., Vancouver, B. C.

Firms winning three awards included East Ohio Gas Co., Cleveland; Hope Natural Gas Co., Clarksburg, W. Va.; Intermountain Gas Co., Boise, Idaho; Kansas Power & Light Co., Topeka; Pacific Gas & Electric Co., San Francisco; and Western Kentucky Gas Co., Owensboro.

ASA index published

The American Standards Association has published its 1960 Price List and Index of American Standards. Listed are nearly 1900 American Standards. The list is available free of charge from the ASA, Dept. PR 151, 10 E. 40th St., New York 16.



The 155's close side-clearance puts trench within 21 inches of fences, poles, walls. Power-shift spoil conveyor dodges side-obstructions. Belt-direction is instantly reversible, conveniently places spoil bank on either side of trench.

Puts trench within 21 inches of side-obstructions

Compact profile of the Parsons 155 Trenchliner is your answer to fast trenching in congested areas. Low height of 7′ 4″, and width of only 5′ 4″ over crawlers, permit digging under low-hanging trees, close to utility poles, and other side-obstructions.

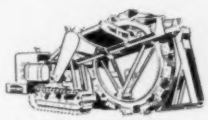
Opens trench at 25 ft./min.

For all its compactness, the 155 opens trench 16″ to 26″ wide, up to 10 feet deep, and at 60 digging speeds from 5.8 inches to 25 lineal feet per minute. This lets the 155 "inch" its way past cross-pipes and other underground obstructions, or "open up" for maximum progress on clear right-of-way.

The 155 undercuts walks, curbs, and cross-pipes; also makes vertical set-ins to save hand digging and clean-up. Positive down-crowd boom starts cut fast, holds accurate grade.

For more facts on low-cost-per-mile trenching, see your local Parsons® distributor, or write us today.

ladder-type Trenchliner



wheel-type Trenchliner

backhoe-loader attachments

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Air conditioned school experiment in Florida

Can an air-conditioned school be built for the same cost as a non-air-conditioned school? It can cost even less, according to first indications from an experiment now in progress in Florida.

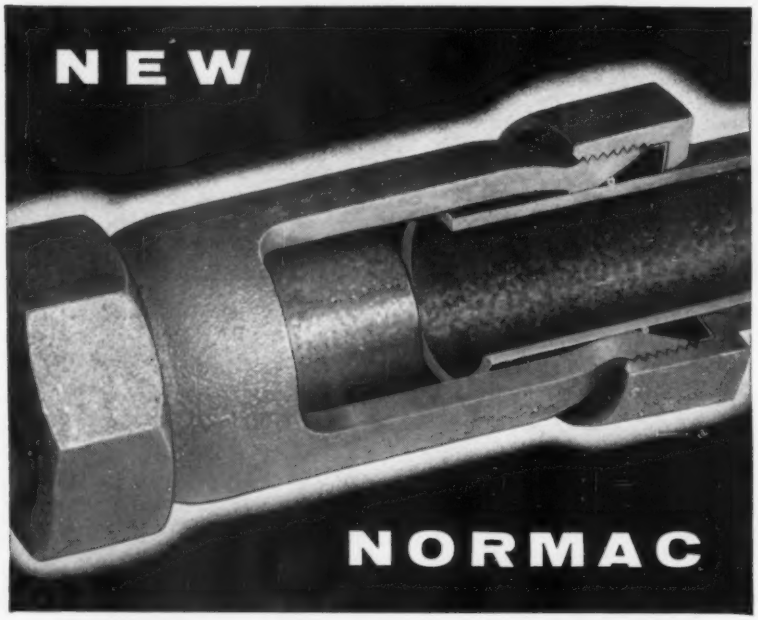
The Pinellas County school board is building two junior high schools which are virtually identical in size, materials, and other respects. The one big difference is that one is designed specifically for air conditioning while the other will take advantage of prevailing breezes with help from exhaust fans and a spread-out floor plan. Different architects were used for the two schools, but the same consulting engineering firm was employed for both and every effort was made to insure a fair test.

Although the base bid for the air-conditioned Oak Grove school was made five months later than for the non-air-conditioned Pinellas Park school and construction costs had definitely increased in the interim, the bid for the air conditioned school was $1849 less.

Considerably greater savings are expected within one year when both schools are enlarged from 16 to 32 classrooms. At Oak Grove, the gas boiler and piping are sized for 32 rooms and the air conditioning compressors are believed adequate for eight new rooms. At Pinellas Park, such is not the case, since several residential-type gas furnaces serve adjoining classrooms.

The school board is not merely interested in first costs, but is planning a detailed comparison of operating expenses, attendance, increased use of school facilities, and educational effectiveness.

The particular significance to gas interests is that if air conditioned schools can be built somewhat cheaper where the air conditioning load is heavy and the heating load is light, they should be much more cheaper where the air conditioning load is light and the heating load heavy.



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MALLEABLE SERVICE ELL
Maximum stab. All sizes, with or without insulating gaskets. Also in brass 1¼ I.P.S.

BRASS FITTINGS
The most complete line for copper or plastic tubing in ⅝, ⅞, 1⅛, 1⅜ O.D., 1¼ I.P.S.

Top Quality for 22 Years in Gas Distribution Equipment

Get helpful CATALOG 12. Photos, specs, detail drawings & much helpful data for modernizing or new installations.

PERMANENCY Rely on NORTON-McMURRAY for the finest! NORMAC continues to modernize and improve couplings and fittings in step with latest gas distribution demands. 22 years experience concentrated on ONE purpose . . . the BEST! Today, major gas distribution companies say "NORMAC" to define their standard of quality.

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B. C. Electric triples supply

B. C. Electric is building a 30-in. line through British Columbia's Fraser valley. The line will triple the amount of gas available to Lower Mainland customers in the province.

When completed in '62, the line will run from Huntingdon (where B.C.E. receives Peace River gas from Westcoast Transmission Co. Ltd.) to the existing system in North Surrey.

Fisher expands in England

A recent visitor at Fisher Governor Co.'s Marshalltown, Iowa plant was Philip Carpenter, head of the company's gas equipment building program in Rochester, England.

The English plant is preparing to manufacture gas regulators, and Carpenter has been studying their design and production in Marshalltown.

Utility handles Char-Glo

Utility Appliance Corp., Los Angeles has obtained national and international distribution rights for all Char-Glo home cooking products. Utility's Gaffers & Sattler Product division will distribute the indoor and outdoor gas-fired units. Joe Del Francia Co. Inc., Los Angeles, is manufacturer of Char-Glo.

Merchandising awards go to Los Angeles utilities

Southern California and Southern Counties Gas companies received special merchandising citations from LOOK Magazine. The awards were for outstanding service to the home building industry. They were presented at the annual convention of the Public Utilities Advertising Association.

The winning companies were cited for giving extensive cooperation to leading home builders in their areas in the development of new subdivisions and the sale of newly erected homes.

Grayson wins safety award

Grayson Controls division of Robertshaw-Fulton Controls Co. has won the National Safety Council's Award of Honor.

Grayson, located in Long Beach, Calif., was one of only 21 plants in the machinery field selected for the council's highest award.

The plant completed more than 3 million consecutive manhours of operation without a disabling injury from Sept. 24, 1958 to Dec. 31, 1959. The precise total is 3,809,896 manhours. Grayson's safety record continued beyond the cutoff date of Dec. 31, until March 24, 1960, for over 4 million consecutive manhours without a lost-time injury.

Meter committee meets

The gas meter committee of the AGA held its 20th annual dinner during the recent AGA distribution and transmission conference in New Orleans.

Among those attending were: Fred Peters, chairman of the meter group and superintendent of gas measurement, New York State Electric & Gas Corp.; Robert L. Jones, vice chairman of the committee, and senior administrative assistant, Michigan Consolidated Gas Co.

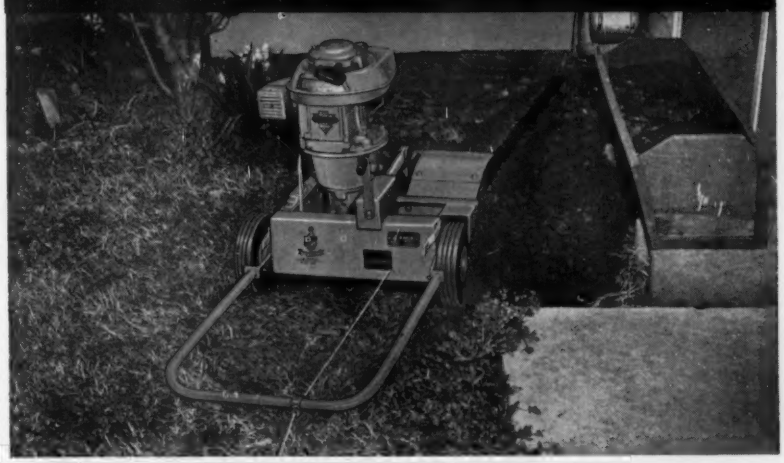
Master of ceremonies was M. J. Harper, Rockwell Manufacturing Co. In all, 30 gasmen attended the dinner.

Barber-Colman expands

Barber-Colman Co. is expanding its plant facilities in Rockford, Ill. Additions will increase present plant area by about 170,000 sq ft.

the DAVIS PUP TRENCHER

IS POSITIVELY SELF-PROPELLED



trenches while you do other work!

The portable, self-propelled Davis Pup Trencher has proven itself as the most valuable trenching tool available for assignments from 2" to 3" wide to 36" deep or 4" wide to 18" deep. Users have reported it has paid for itself on the very first job.

It is positively driven by a simple, six-speed winch mechanism that pulls it down the line you want dug. Since it doesn't require constant supervision, you are free to take care of other work on the job — such as prepare pipe or cable for the trench. It disturbs a minimum of turf so backfilling is easy.

The Davis Pup has quality features throughout, but it is still priced less than comparable trenchers. Compare it for performance, quality, and price. See if you don't agree that pound for pound, dollar for dollar, it's your best trenching buy!

and if you need to go larger — the NEW DAVIS T-66 fills the bill!

This amazing trencher features positive traction, hydraulic variable speed drive, accurate speed control, hydraulic boom control, preloaded shock absorbing boom, and convenient — virtually effortless — operation. Digs 3" to 4" wide to 66" deep or 12" wide, 30" deep and varying depths and widths in between. Compact design with 1350 lbs. total weight; only 37" wide. Has well-designed backfill blade attachment, two-speed drive with instant forward or reverse, and many other features. Ask about its 90-day unconditional guarantee!

the PERFECT VEHICLE FOR TRANSPORTING TRENCHERS AND SUPPLIES

THE DAVIS HUSTLER

This 2000-lb. capacity utility trailer was especially designed for the T-66, but it has a wide range of uses. Deck is 48" x 84". It has a low center of gravity and provides load equalization regardless of load distribution.

DAVIS MFG. INC.

1508 South McLean Blvd., Wichita 13, Kansas

Please send me literature and tell me the name of the distributor for the Davis Pup____Davis T-66____Davis Hustler Utility Trailer____

NAME_____

ADDRESS_____

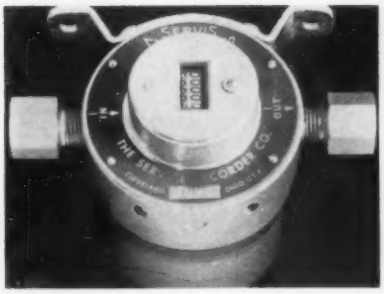
TOWN_____ STATE_____

P-60-2

GAS DIGEST

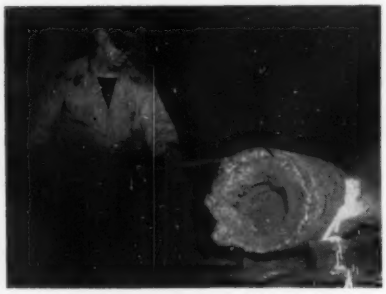
New Products and Trade Literature

For more data on any of these items use the Readers' Service Card on pages 81, 82



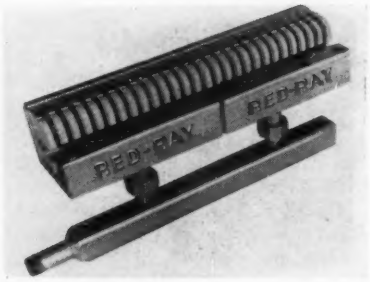
1. Lube oil meter

Reliable, automatic records of lubricating oil consumption are kept by a new lube oil meter (Model A). Designed for mounting on compressors of all types, the meter provides a continuous check of the make-up oil used. The meters have no minimum flow requirements. *GEC-760*
Service Recorder Co.



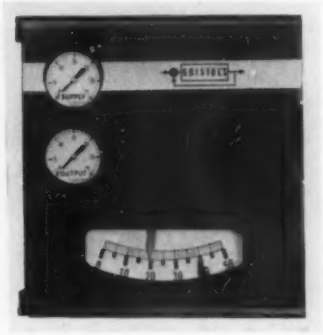
3. Cutting torch

A natural gas cutting torch can slice through 30 in. of metal in a single pass. Oxweld C-66 has gas flow of up to 3000 cfh of oxygen and 250 cfh of natural gas. Ideal for removing large risers, it has special uses such as gouging, rivet piercing, and pad and fin washing. *GEC-780*
Linde Co.



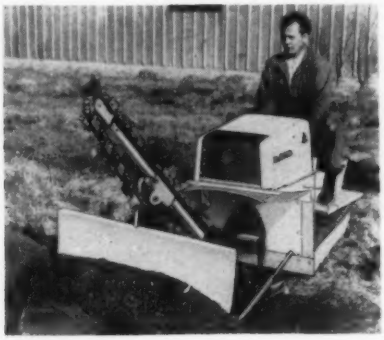
5. Infra-red burner

High-radiation type "H" burner provides from 150 Btu to 3000 Btu per linear inch, depending upon gas-air mixture supplied. Heat release is equivalent of from 45 to 900 watts per linear inch. It is particularly suitable for oven, conveyor, rotary drum, and roll dryer applications. *GEC-400*
Red-Ray Manufacturing Co.



2. Pneumatic controller

Bristol's new indicating pneumatic controller features simplicity and control stability. The new controls (Model 624) are available for proportional control and reset control. Uses include: control of pressure, temperature, flow and differential pressure, humidity, and differential liquid level. *GEC-750*
Bristol Co.

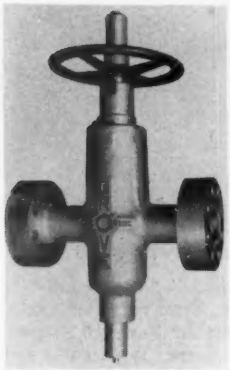


4. Trencher

The 1960 Davis T-66 trencher is equipped with its own backfill blade. The blade can be raised or lowered hydraulically and can be set straight or angled to the left by a simple pin setting. The 37-in. wide rig offers two-speed gear reduction: low for creeping and high for dozing or transport. *GEC-210*
Davis Manufacturing Inc.

6. Fire extinguisher

A novice using Ansul's new 350-lb wheeled extinguisher for the first time should be able to put out a standard gasoline pan fire 160 sq ft in area. The drychemical extinguisher has a 160-B:C rating from the Underwriters' Laboratories, a new high for 350-lb extinguishers. *GEC-710*
Ansul Chemical Co.



7. Balanced stem valve

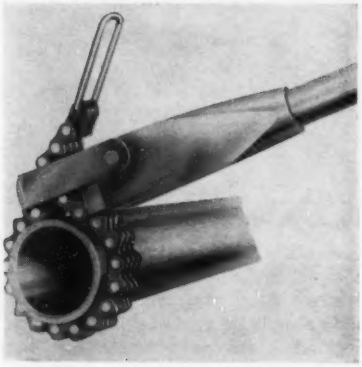
Grove's new valve is for general high pressure service. Balanced stem consists of two shafts placed opposite each other and leading in from top and bottom of body. The gate links them. Operating stem pulls against balancing stem, balancing pressure load. Gate stem moves freely. *GEC-820*
Grove Valve & Regulator Co.

8. Cold-applied coatings

Two Bituplastic cold-applied protective coatings are highly resistant to chemical permeation. No. 33 is a heavy duty coating suitable for intermittent splash and high chemical "fallout" areas. Its high resistance to abrasion and high temperature tolerance (up to 400 deg F) extend range of probable use. No. 44 is ideal as top coating for insulation. *GEC-130*
Koppers Co. Inc.

9. Radio receiver

An all-transistorized shirt-pocket personal radio communications receiver with miniaturized circuitry boosts audio efficiency. G-E's pocket radio requires 35 per cent less battery power than previous hand-carried message equipment of its type. With battery, it weighs 12 ounces. *GEC-140*
General Electric



10. Pipe-turning wrench

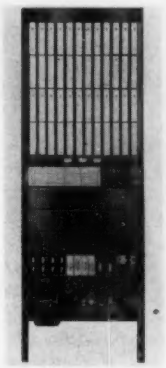
A new pipe-turning wrench features a new use of torsion to exert a positive but smooth grip around the entire circumference of the pipe. Torzion-Grip wrench is designed to turn round and odd shapes of pipe, tubing, etc., without slipping, scratching or gouging surface. *GEC-770*
Alladin's Products Inc.

11. Holiday detector

Constant voltage in any climate is provided with a new holiday detector. Portable Model HP does not require a generator. A new electrical field device is attached directly to the instrument carrier. It creates a constant inspection voltage on the pipe which is adjustable from 5 to 20,000 kv. Weather or ground conditions do not affect operation. *GEC-760*
Tinker & Rasor

12. Gas refrigerator

Whirlpool's "no-frost" gas refrigerators are all combination refrigerator-freezers and 13 cu ft in size. They feature Jet-Cold shelf, Jet-Cold meat chest and Million-Magnet door seal. Top-of-the-line GA-1400 supplies over 100 ice cubes automatically every 24 hrs. *GEC-690*
Whirlpool Corp.



13. Fault-finder

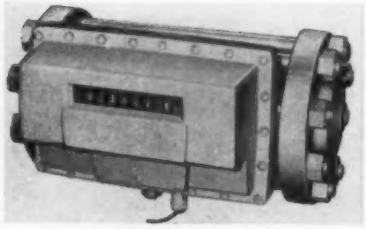
Shown here is the master alarm station of Motorola's MA-1 alarm and fault-finding system. The alarm station consists of an indicator panel, alarm panel, coding and decoding chassis, and tone transmitter and receiver. The system accommodates 24 stations with up to 20 functions each. *GEC-140*
Motorola Inc.

14. Synthetic primer

A synthetic primer in brilliant red has been developed and will be marketed under the trade name, "Reilly Redhead." The primer has ability to develop high initial bond, is quick drying, and designed for use in difficult drying and application conditions. The coal-tar primer dries to touch within 10 minutes, will accept enamel within 2 hr. *GEC-610*
Reilly Tar & Chemical Corp.

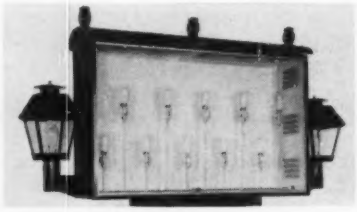
15. Flame-proof gloves

Three new types of gloves reflect 90 per cent of all radiant heat in work where high temperatures are involved. Leather palms and aluminized asbestos backs and thumbs make gloves particularly suitable for welding and cutting operations or where extreme radiant heat is an important factor. *GEC-121*
Air Reduction Pacific Co.



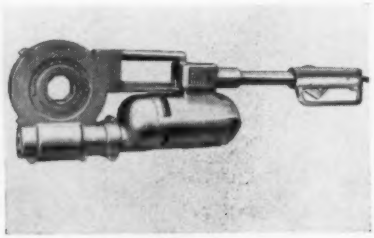
16. Mass flowmeter

On the market is Black, Sivalls & Bryson's new mass flowmeter for natural gas. The "true mass" flowmeter makes possible the measurement of gas directly in pounds, eliminating calculations for conversion to weight. It was developed jointly by BS&B and General Electric Co. *GEC-560*
Black, Sivalls & Bryson



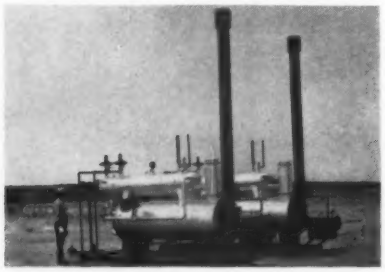
19. Gas sign

Arkla's new commercial sign is completely illuminated, operated and animated by gas. Gasign consists chiefly of two highly tempered frosted glass side-panels for the user's message. They are mounted on a metal frame, with a row of mantle-covered gas burners glowing inside. *GEC-550*
Arkla Air Conditioning Corp.



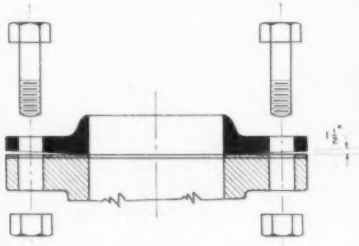
22. Pipe threader

The Sioux portable power pipe threader threads ¼- to 4-in. pipe. The versatile tool will thread bolts; with an auger it will dig holes; in use with a portable winch it will lift up to 1000 lb; and it will open and shut valves. *GEC-770*
Albertson & Co. Inc.



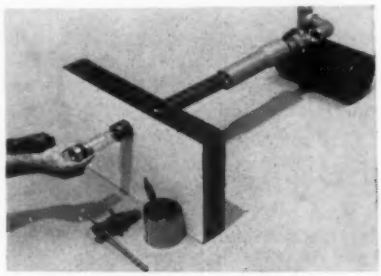
17. Gas condensate production

A new gas-condensate production unit is available. The Thermosiphon Stak-Pak is a pre-piped, skid-mounted unit. It combines any National 2- or 3-phase horizontal separator together with any size indirect heater. In moderate climates, no housing or insulation is needed. *GEC-300*
National Tank Co.



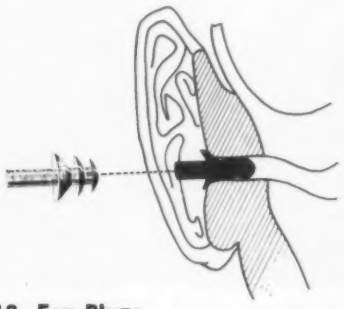
20. Taper-face flanges

Tube Turns has doubled the size range of its welding neck flanges to include 14- through 24-in. pipe sizes. Light weight reduces disparity in strength between it and mating cast iron flanges, avoiding breakage. Taper concentrates gasket pressure near bore, requiring low sealing force. *GEC-370*
Tube Turns



23. Plastics renewal kit

A complete service renewal kit provides a gas-tight tie-in between plastics tubing and metal house pipe. Included in the kit: a service head adapter, both inner and outer reinforcing butyrate sleeves, butyrate tubing to insert in old line; and solvent cement for welding. *GEC-370*
Perfex Plastics Inc.

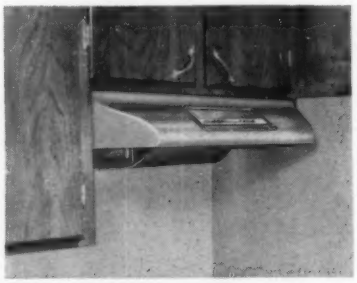


18. Ear Plugs

A new ear plug has been developed to protect against noise problems in the gas industry. New design and material make possible the highest reduction of sound plus exceptional comfort. Com-Fit ear plugs are molded of a special formula silicone rubber. They are made with a triple flange. *GEC-121*
Sigma Engineering Co.

21. Overhead heater

Quick infra-red spot heat is provided by Solarflo radiant overhead heaters. Circular burner head and pilot are enclosed above saucer-shaped, ceramic-coated metal radiating surface over which the flame projects horizontally. No fans, motors, or limit switches are used. *GEC-410*
Solarflo Co.



24. Ventilating hood

Ductless ventilating hood removes smoke, grease, odors, etc. from kitchen. Laden air is drawn into hood where particles are charged by an electronic device. Air then passes over filter with plates that attract the particles. Sweet, clean air is returned to the room. *GEC-840*
Caloric Appliance Corp.

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TRADE LITERATURE

25. Corrosion resistant

Corrosion resistance of tin and ductility of copper are combined in a new tin-lined copper tubing. It's immune to sulfur conditions sometimes found in natural gas. Especially suitable for main-to-meter service replacements, the tubing is easily inserted into old piping without the lining cracking or stripping when bent, flared or soldered. It is available in continuous coiled lengths in sizes from ⅛- to ⅝-in. O.D. *GEC-810*
Phelps-Dodge Copper Products

26. Gas lift

Garrett Oil Tools describes its Opti-Flow gas lift in a Handbook of Gas Lift. Answered are such questions as: How deep and at what pressure should gas be injected for maximum return with minimum compressor hp? What effect does existing wellhead backpressure have on well design? What tubing size would produce the well at desired rate? How can you get full operating pressure to the point of injection without excessive loss on deep wells? *GEC-300*
Garrett Oil Tools

27. Alarm-control

G-E's bulletin ECM 119 describes how a high-capacity alarm-control system provides an inexpensive method of locating faults at unattended remote operations and controlling "on-off" functions remotely. *GEC-750*
General Electric Co.

28. Pulse width selection

A technical brochure explains the operations and applications of the Hammarlund pulse width selection systems. Hammarlund's PWS system permits remote supervisory functions with 128 channels of information in both directions. *GEC-750*
Hammarlund Manufacturing Co.

29. Promotion portfolio

A marketing kit and promotion portfolio catalogs dozens of Speedy Therm items. Complete advertising, merchandising, and public relations material available is described. *GEC-550*
Speedy Therm Co.

30. Two-way mobile radio

Complete descriptions of all two-way mobile radio base station equipment are contained in a new booklet from Motorola. Specifications and photos are included as are descriptions of various base station antennas, monitor receivers, and Motorola's selective signalling system. *GEC-140*
Motorola Inc.

31. Gas cocks

Construction features of the complete line of Eclipse gas cocks are described in bulletin 600-2. They have an iron body with brass core of either the standard or "retained key" type. *GEC-820*
Eclipse Fuel Engineering

32. Gas flow computer

Honeywell's gas flow computer automatically and continuously measures and records mass flow on an Electronik recorder. IDS 7.08 covers its application for single and multiple meter runs and for telemetering systems. *GEC-750*
Minneapolis-Honeywell

33. Wet test meter

Wet test meters in capacities to 1200 cfh are covered in Bulletin 501. Included are data on capacities, calibration, indexes, dimensions, and special models. *GEC-570*
American Meter Co.

34. Indicating meter

New literature describes indicating bellows meters which combine traits of the mercury-less bellows meter body with a rugged, easy-to-read 6-in. dial indicator. Spec Sheet S224-1 tells how the meter can be used for any flow, and open or closed tank liquid level use where recording or transmission is not required. *GEC-560*
Minneapolis-Honeywell

35. Remote-reading meters

Remote-reading, electrical flow meters for all types of gases and liquids are covered in Bulletin 59.5. Principles and engineering features are described. *GEC-560*
Republic Flow Meters Co.

36. Eccentric valves

DeZurik's eccentric valves are covered in a new 8-page bulletin (No. 110). Features, materials, pressure ratings, dimensions, and accessories are covered. *GEC-820*
DeZurik Corp.

37. Telemetering

A 52-page bulletin (No. M1715) describes Bristol's Metameter telemeters. Gas distribution and transmission installations are described. Discussed are principles of operation, types, applications, etc. *GEC-750*
Bristol Co.

38. Return bends

A new line of malleable iron return bends—for quick, safe meter installation—is covered in Bulletin 500-2. According to Eclipse, the return bends reduce the number of threaded joints in meter installations. *GEC-620*
Eclipse Fuel Engineering Co.

39. Air Conditioning

A complete library of air conditioning promotion has been published by Arkla. Included are newspaper ad ideas, color brochure on commercial application, new builder bulletin, and new mailing insert. *GEC-550*
Arkla Air Conditioning Corp.

40. Seamless welding fittings

Midwest Piping has added seamless-type welding fittings to its line of welded-type fittings. Bulletin 60-C covering the new fittings includes photos and general information plus manufacturing operations, dimensional and metallurgical control processes, and testing. *GEC-370*
Midwest Piping Co.

41. Consultant's role

Where the consultant fits in business management is described in a 40-page booklet. Highlighted is the growing complexity of management functions. It reviews one consulting firm's approach to management problems. *GEC-330*
Commonwealth Services Inc.

42. Piping systems

Piping systems fabricated and erected by Midwest Piping are highlighted in a 24-page bulletin (60B). Case histories, along with interior and exterior photos and details, are included. *GEC-620*
Midwest Piping Co.

43. Rigid meter bars

Eclipse Bulletin 200-2 covers a wide variety of rigid meter bars. Three basic types are listed: union, sleeve, and compression. *GEC-560*
Eclipse Fuel Engineering

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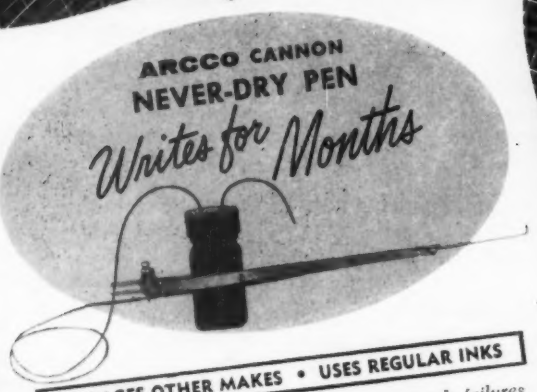

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people • *Continued*

from page 65

A. G. PRASIL is the new chief engineer for Southern Union Gas Co., Dallas. He is in charge of all phases of Southern Union's engineering operations throughout its gathering, processing, transmission, and distribution systems in Texas, New Mexico, Arizona, and Colorado.

HAROLD E. SCHWALM has been named to the newly created post of superintendent of storage by Northern Illinois Gas Co., Bellwood, Ill. D. V. MEILLER succeeds him as superintendent of supply. He formerly was in charge of NI-Gas' supply system.

F. G. FABIAN JR. has been promoted to executive vice president of Dresser Industries Inc., Dallas. He has been president and general manager of Dresser Manufacturing division of Dresser Industries since 1955. In his new post, Fabian is responsible for five divisions: Guiberson Corp., Ideco division, Security Engineering division, Lane-Wells Co., and Magnet Cove Barium Corp. CHARLES KUHN becomes president of Dresser Manufacturing in Bradford, Pa. Kuhn has been vice president and sales manager of the division. JOHN V. JAMES has been promoted to controller of the parent company in Dallas. James has been vice president-finance of Clark Brothers Co. at Olean, N. Y.

Several sales personnel changes were made by United States Pipe & Foundry Co., Birmingham, Ala. WHITNEY K. STEARNS is sales agent in charge of the New York office. He is succeeded as Boston sales agent by JAMES J. MCCARTHY. And, WILLIAM J. WOLFERSHEIM succeeds McCarthy as head of the Detroit office.

A. G. Prasil
Southern

F. G. Fabian Jr.
Dresser

H. E. Schwalm
NI-Gas

D. V. Meiller
NI-Gas

New Orleans (La.) Public Service Inc. elected ISADORE NEWMAN II to the board. FLOYD W. LEWIS, formerly assistant to the president and executive counsel, was elected a vice president. He joined NOPSI in 1949.

JOHN J. CRILLY, assistant vice president, operations, at Elizabethtown Consolidated Gas Co., Elizabeth, N. J., was honored recently on his 50th anniversary with the company. He joined the company in 1910 as an automobile cleaner.

GEORGE POPE MACNICHOL JR., president of Libbey-Owens-Ford Glass Co., has been elected a director of Columbia Gas System's parent company.

JEAN RAYMOND, president and general manager of Alphonse Raymond Ltd., is a new director of Quebec Natural Gas Co., Montreal.

KEN KANE is natural gas superintendent of Saskatchewan Power Corp.'s Grenfell gas division. He heads gas distribution services at Grenfell, Wolseley, Broadview, Indian Head, Qu'Appelle, Fort Qu'Appelle and Balcarres.

JOHN R. MILLS has joined Schramm Inc., West Chester, Pa., as sales manager of the Rotadrill division.

Charles Kuhn
Dresser

John James
Dresser

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ROBERT A. MODLIN has been promoted to assistant general sales manager of East Ohio Gas Co., Cleveland. Modlin has been industrial sales manager since 1958. WILLIAM H. HARPER JR. has joined East Ohio as sales promotion manager.

J. PAUL LEINROTH has retired after 38 years with Public Service Electric & Gas Co., Newark, N. J. He leaves as manager of industrial and commercial sales. Leinroth started with Public Service in 1922 as general industrial fuel representative.

DALE TE KOLSTE has been promoted to vice president and general manager of the Peoples Natural Gas division of Northern Natural Gas Co., Omaha. Te Kolste succeeds DONALD L. SEDGWICK, who has retired. Te Kolste joined Northern in 1948. In 1958 he was made

D. L. Sedgwick
Northern-Peoples

Dale TeKolste
Northern-Peoples

administrative assistant in the Peoples division. Last year he was promoted to assistant general manager. Sedgwick, in the gas industry since 1919, joined Northern in 1951. In 1958 he was named general manager of the Peoples division and was elected a vice president of Northern in the same year.

MAX R. LLEWELLYN has been promoted to manager of gas and electric operations of Arizona Public Service Co., Phoenix. He succeeds MALCOLM M. BRIDGWATER, who is now manager of the company's power contracts and scheduling departments.

ROBERT P. LEE has been named assistant to Paul V. Hayden, vice president in charge of public and employee relations at Connecticut Light & Power Co. Lee will continue as manager of the company's area development department.

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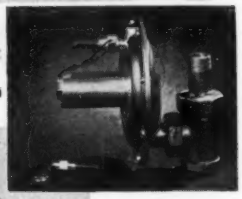

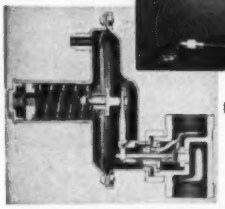

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Rochester (N. Y.) Gas & Electric Corp. elected HAROLD S. WEATHERBY vice president and controller and PAUL W. BRIGGS secretary. Newly elected assistant vice presidents include: FREDERICK J. PFLUKE, general superintendent of gas division; FRANCIS E. DRAKE JR., manager, rate and economic research department; and SCHUYLER F. BALDWIN, director of public relations.

F. J. Pfluke
Rochester

F. E. Drake Jr.
Rochester

H. S. CAIN is sales manager of Berry Hydraulics, a division of Oliver Tyrone Corp. He will headquarter at the general sales office in Corinth, Miss. Cain formerly was district sales manager.

KENNETH L. HAND has joined Walworth Co., New York, as assistant to the marketing manager.

S. F. Baldwin
Rochester

H. S. Cain
Berry

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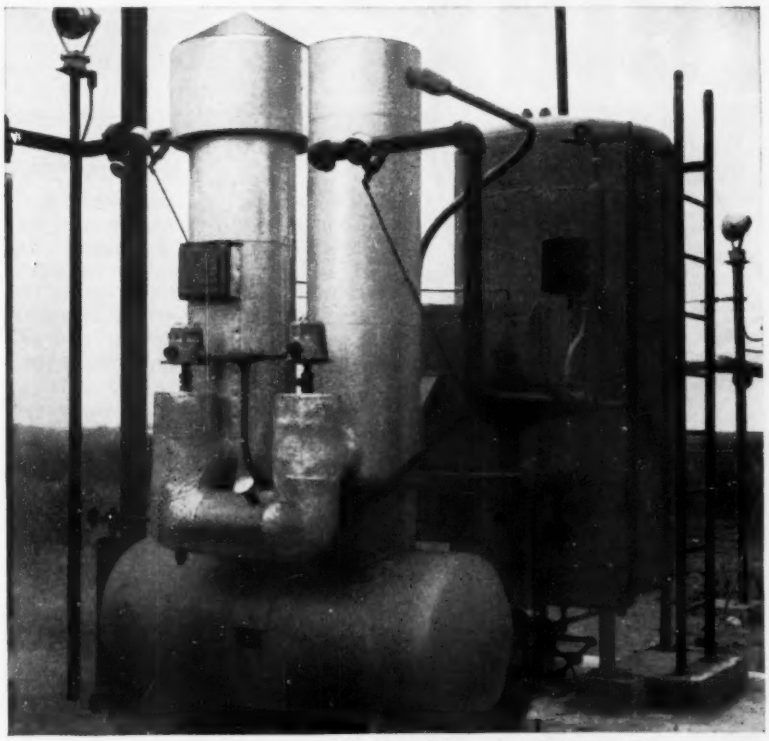

The Koppers-Baltimore electric Oil Fogger, 100 gallon capacity, newly installed at the East Rutherford Natural Gas Metering and Regulating station—the Public Service Electric and Gas Company, Newark, N. J.

FOG TO REDUCE "UNACCOUNTED FOR"

The Koppers-Baltimore Oil Fogger produces a very fine oil mist, which when introduced into gas mains, helps condition main joints, minimizes gas leakage, controls dust problems and reduces equipment maintenance.

New design principles permit treatment of several sections of a distribution system by a single oil fogger, even though each section operates at a different pressure.

The Koppers-Baltimore Oil Fogger is the only hot fogger that virtually eliminates stoppages due to carbonizing and oil sludge.

Koppers has been providing equipment for the gas industry for more than 80 years. Find out how this broad experience can benefit you . . . write today to: KOPPERS COMPANY, INC., Gas Apparatus Department, 2007 Scott Street, Baltimore 3, Maryland.

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GLENN R. PETERSEN has been named manager of marketing for General Electric Co.'s communication department in Lynchburg, Va.

NICHOLAS J. LESSELYOUNG has been named vice president and general counsel of the Milwaukee (Wis.) Gas Light Co.

Four new vice presidents have been elected by Commonwealth Natural Gas Corp., Richmond, Va. They are: CHESTER E. STARKEY, OSMOND T. JAMERSON, PAUL H. RILEY, and HARVEY S. GERMAN. Starkey was assistant secretary and assistant treasurer from 1951 to 1957, when he became assistant to the president. Jamerson has handled public relations for Commonwealth since 1953. Riley was superintendent of measurement and transmission for Owens-Libby-Owens Gas Co. before joining Commonwealth. His new post is vice president and chief engineer. German is being promoted from superintendent of pipelines and construction to vice president for maintenance and construction.

CHESTER S. CRAWFORD, president of Whitehall Cement Manufacturing Co., has been elected to the board of directors of American Meter Co.

Several sales executives have moved up a rung at Whirlpool Corp., St. Joseph, Mich. HARPER R. DOWELL, former distribution manager, is general manager of distribution and sales. THOMAS F. BARTLEY moves from field sales manager to general sales manager. C. R. ARMSTRONG, former general manager of the Detroit sales division, is general manager of branches, supervising wholesale activities in Detroit, Atlanta, and Jacksonville. C. EDWARD REINER succeeds him in the Detroit branch. RAYMOND A. MULDOON, national advertising manager since 1958, succeeds Reiner as sales manager of automatic washers. QUENTIN B. GARMAN is now national advertising manager, assisted by RONALD I. GOW. JAMES D. WALKER becomes West Coast regional manager, and STERLING L. BECK JR. succeeds Walker as district manager in the Southeast. A new dealer sales development team is headed by FRANKLIN T. GRIMES, assisted by L. EARL MITCHELL.

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M. H. Grove
Walworth

M. J. Markle
NI-Gas

W. E. Preston
NI-Gas

C. J. Gauthier
NI-Gas

Northern Illinois Gas Co., Bellwood, has elected three new vice presidents. They are MATHEW J. MARKLE, who will head engineering, construction, supply and storage departments; WILLIAM E. PRESTON, in charge of personnel, long-range planning, and research; and C. JOSEPH GAUTHIER, heading secretary and treasurer functions as well as purchasing, stores, real estate, local taxes, claims and insurance work.

MARVIN H. GROVE has been named chairman of the executive committee of Walworth Co., New York. He also was named to the newly created post of chief executive officer. Grove is president of Walworth's subsidiary, Grove Valve & Regulator Co., Oakland, Calif.

CHARLES J. HAINES, president of Chemetron Corp., Chicago, was elected to the new post of chairman and chief executive officer. JAMES W. DUNHAM, vice president and chairman of the finance committee, was elected president. He continues as finance chairman.

MERLE CALL has joined Holan Corp. of Georgia, Griffin, Ga., as sales manager.

JAMES F. MCDONALD has been promoted to superintendent of measurement at Commonwealth Natural Gas Corp., Richmond, Va. He joined the company in 1957 as assistant superintendent of measurement.

ROBERT F. BENDA is a new sales representative for Superior Meter division, Neptune Meter Co. Headquartered in Houston, Benda will cover Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

LOUIS G. GOOD is vice president in charge of operations for Panellit Service Corp., Skokie, Ill. . . . Rotron Controls Corp., Woodstock, N. Y., named ARTHUR L. LANDESMAN to post of sales manager . . . HAROLD P. MUELLER JR. has succeeded his father as president and general manager of the Mueller Climatrol division of Worthington Corp., Milwaukee . . . Norge division named B. J. GLASCOCK central regional manager, Kansas City, Mo., and ROBERT F. WAMMACK, manager of built-in range sales in the Southwest . . . MERRILL PRESTON has joined Caloric Appliance Corp., Topton, Pa., as product engineer.

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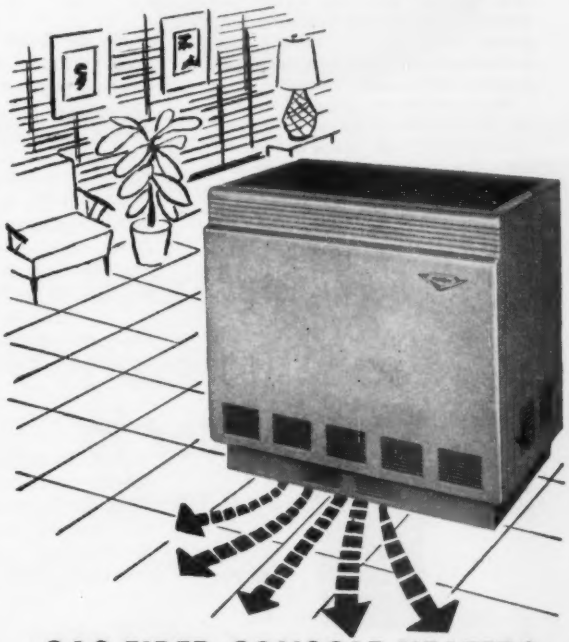

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ROCKWELL TYPE "T" EMCORECTOR—chart is clock driven. One pen traces an accurate record of pressure against time. A second pen records volume in units of either 1,000 or 10,000 cu ft. Two straight reading indexes are provided—one for actual displaced measurement while the other automatically corrects this to base pressure volume.

ROCKWELL COMBINED RECORD GAUGE. Has clock driven chart on which two pens trace (1) gas usage in units of either 1,000 or 10,000 cu ft and (2) gas pressures. These increments can be calculated, if desired, to correct to base pressure volume.

VOLUME AND PRESSURE GAUGES
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RODMAN MCCLANAHAN is president of Middle West Service Co., Chicago; ELMER GATES is a new vice president, as is GEORGE FRANK . . . WALTER E. YEDLINSKY is industrial sales representative in western Pennsylvania for Briggs Filtration Co., Washington, D. C. . . . Newly elected executive vice president of Consolidated Electrodynamics Corp., Pasadena, Calif., is ROBERT H. GARRETSON.

W. E. ROBB has joined Webster Engineering division, Tulsa, as project engineer . . . Southwestern Industrial Electronics Co., a division of Dresser Industries, named W. A. LAUKAITIS as eastern regional marketing manager, and BERNARD W. EADES as manager of value engineering . . . GLENN O. LADD has joined Commonwealth Services Inc., New York, as a senior consultant in the rate department . . . CHARLES M. BRINCKERHOFF is a new director of ACF Industries Inc., New York.

Deaths

ROY RUSSELL GLEASON JR., 38, safety supervisor for El Paso (Texas) Natural Gas Co. Mr. Gleason was division safety supervisor for an area including Utah, Idaho, Wyoming, and Montana.

WALTER H. SWANSON, 52, Minneapolis sales agent for United States Pipe & Foundry Co. Mr. Swanson with with U. S. Pipe for 11 years.

JOHN S. EVANS, 43, manager of Grabler Manufacturing Co.'s Minneapolis branch.

Standing and burning amid the rubble in tornado-hit Sapulpa, Okla., is this gas light. It is one of many that withstood the fury of the May 5 storm. They provided light for rescue work throughout the night as electricity failed over much of the city.

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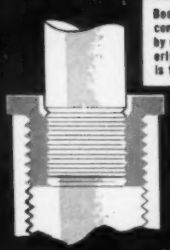

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GAS

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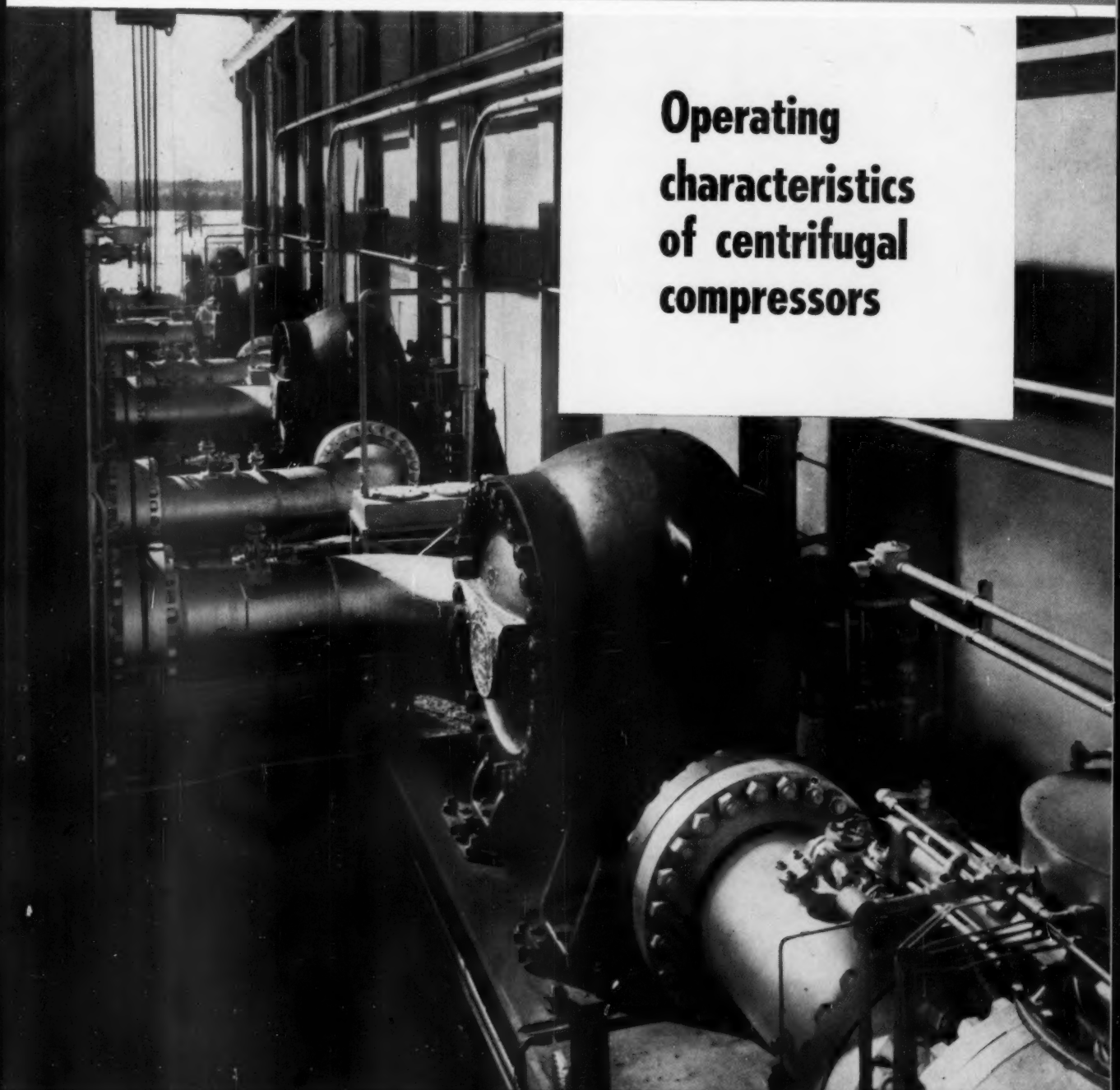
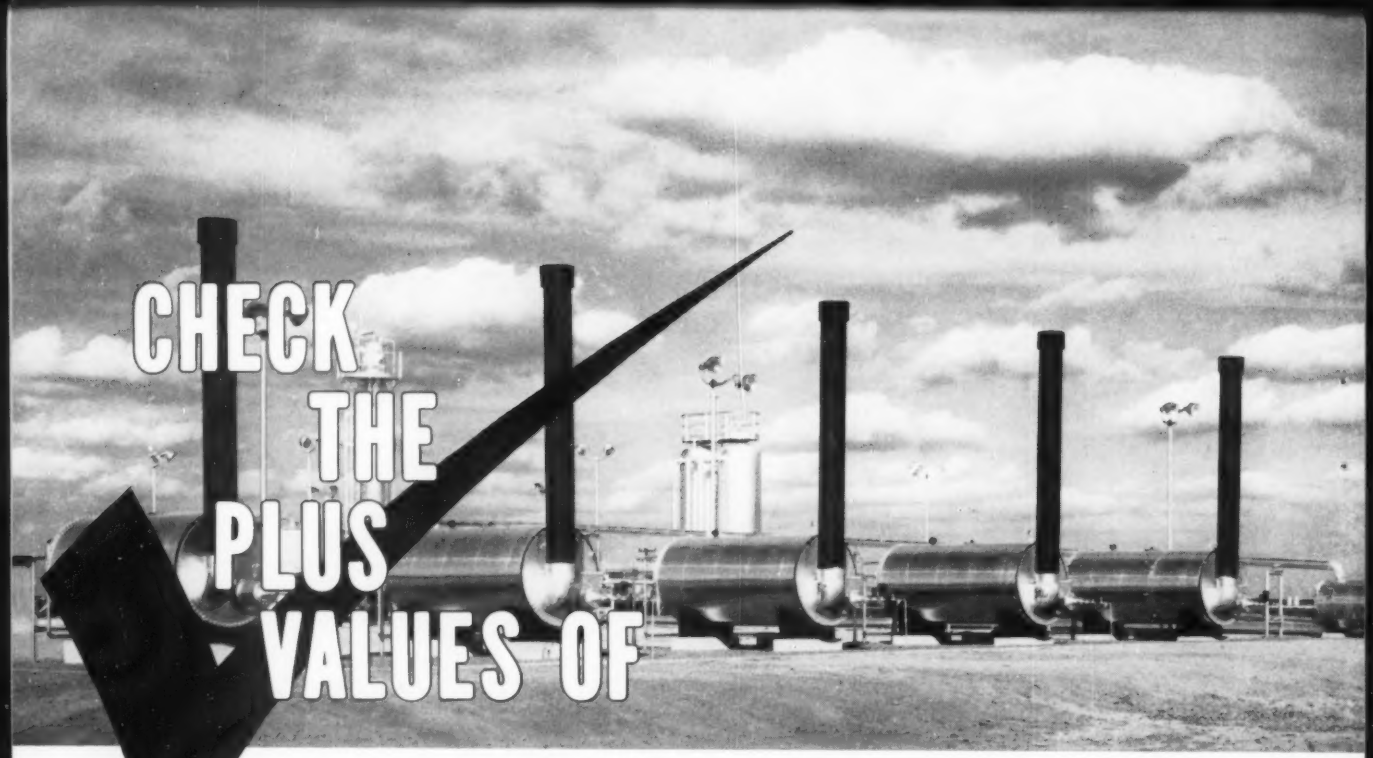


Operating characteristics of centrifugal compressors



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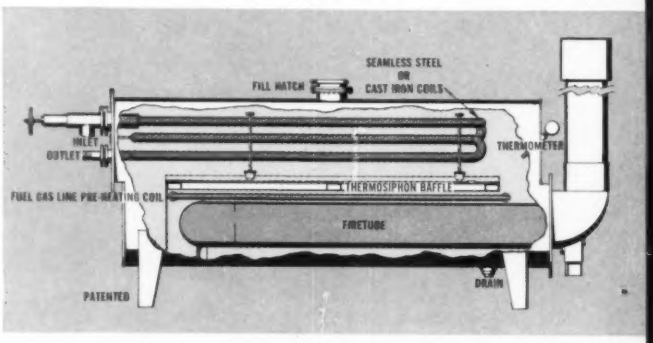

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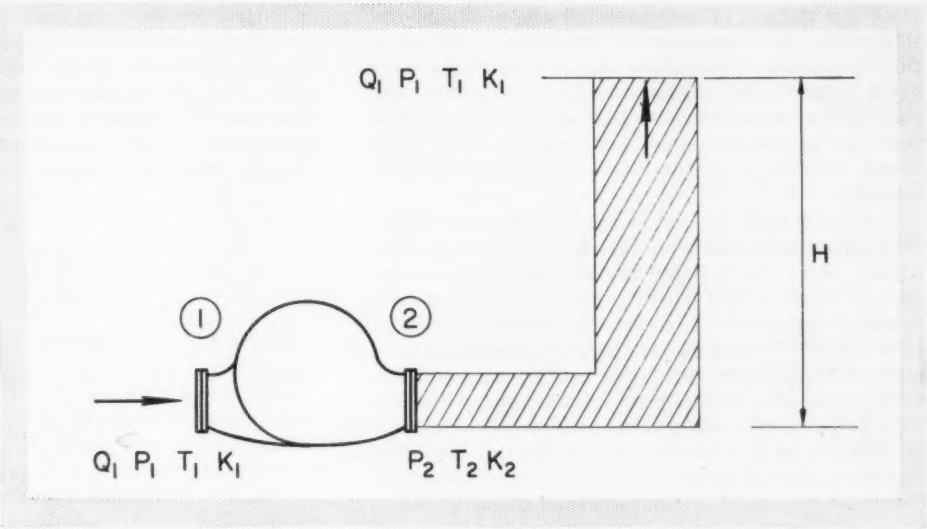


Operating characteristics of centrifugal compressors

By CLARENCE TAYLOR • Gulf Interstate Co., Houston

SINCE World War II, the natural gas pipelines have made revolutionary strides forward. The ever-increasing network of gas transmission lines extends into all parts of the United States. The tremendous growth of natural gas as an industrial and domestic fuel is responsible for this.

To meet the challenge, the industry has undergone a number of revolutionary developments. Thin-wall, high-strength, large-diameter line pipe is a reality. API-SLX pipe not only reduces construction costs. It also allows operating pressures and flows to reach higher and higher values. Operational and maintenance costs have been thoroughly examined by transmission companies and numerous methods of reducing these costs have been explored.

Automation has become a byword of the industry as one feasible means of reducing these costs. The development of the centrifugal compressor for pipeline service is a major step in reducing transportation costs. The logical combination of automation and the centrifugal compressor is now recognized by the industry as being an ideal means of compressing large volumes of gas.

All centrifugal compressors operate on the principle of compressing gas by the dynamic action of rotating blades of one or more impellers. Centrifugal compressors consist of at least three principal parts: an impeller, its bearing assembly and a casing. The casing guides the gas into and away from the impeller. The gas is forced into a rotary motion at high velocity in a continuous process by the impelling action of the blades in the rotating impeller. On leaving the impeller, gas velocity is reduced and converted into pressure by a diffuser action. Thus the pressure rise in a centrifugal compressor is produced by dynamic means.

The actual pressure rise in a centrifugal compressor is referred to as "head." This is a term borrowed

Fig. 1 (above). An illustration of the definition of "head" applicable to centrifugal compressors.

from centrifugal pump nomenclature, where pumps were often used to actually lift liquids from one elevation to another. The height through which liquid is lifted is the "head" produced by the pump. Normally these pumps obtain their suction at atmospheric pressure and temperature and discharge the liquid to a second elevation at the same pressure and temperature.

The term head is applied to centrifugal compressors in the same fashion. *Fig. 1* illustrates the definition. Here the compressor, at one elevation, receives a quantity of gas at its inlet. The suction flow, pressure, temperature and specific weight, are designated Q_1, P_1, T_1 and G_1. If the gas is contained in a pipe or vessel, these properties may be assigned any value. The head is produced by the dynamic action within the compressor. This action increases the velocity of gas as it passes through the impeller. The velocity is converted into pressure as gas leaves the compressor case. The discharge condition is designated as point 2. Here the gas has a higher pressure, temperature and specific weight. If gas at the compressor discharge, point 2, were contained in a vertical pipe, and allowed to expand from the higher pressure and temperature to the original suction conditions, P_1, T_1, G_1 and Q_1, the gas would expand to some stationary height in the vertical pipe. The actual height of this column of gas, if measured in feet, would be the head produced by the compressor.

The horsepower produced by the compressor is simply this head in feet, times the number of pounds of gas compressed per minute. The equation is as follows:

$$\text{Gas h p} = \frac{H \times m}{33{,}000} \qquad (1)$$

In practice the head cannot be measured directly. However, it can be calculated from suction and discharge conditions of the compressor. The head is equal to the thermodynamic work of compression. By assuming an adiabatic process of compression, we may calculate head, employing the standard thermodynamic equation, corrected for supercompressibility:

$$H_{ad} = \frac{ZRT_1}{\left(\frac{k-1}{k}\right)} \left[\frac{p_2}{p_1}^{\left(\frac{k-1}{k}\right)} - 1 \right] \qquad (2)$$

Where k is the ratio of specific heats. Thus gas horsepower (ghp) may be calculated for the compressor using equation (1). If the compression process is assumed to be polytropic, equation (2) should be adjusted to the actual "n" values, as determined by either experience or test, in place of the "k" values. Of the two compression processes, the polytropic is the one that is the closest approximation to the actual.

The true efficiency of a compressor is the output work over the input work. This can be closely determined by actually testing the compressor. The gas horsepower is found from the head, normally calculated with either the polytropic or adiabatic head equation, and a measured mass flow rate. The actual shaft hp input to the unit is obtained from direct measurements. Thus the efficiency of the unit, allowing for mechanical losses, is:

$$\text{Gas EFF} = \frac{\text{ghp}}{\text{SHP} - \text{hp Mech. Losses}} \qquad (3)$$

If ghp is calculated with polytropic "n" values, the resulting efficiency is the closest to true output/input efficiency. The efficiency calculated with adiabatic gas

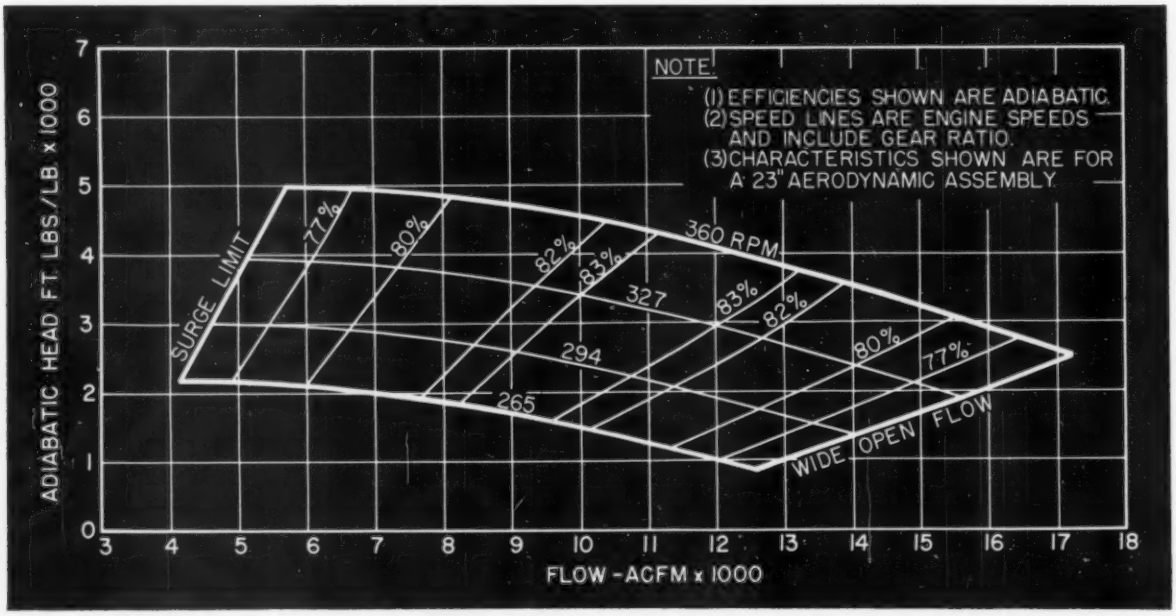


Fig. 2. Centrifugal compressor operating envelope.

horsepower will be less than true efficiency, and less than polytropic efficiency. The basic difference is that the calculated adiabatic head is less than the true head because it does not account for the actual hydraulic losses within the machine. These hydraulic losses are converted into head by increasing the gas temperature. The calculated polytropic head does take into account some of these losses. For these reasons polytropic head is closer to true head and results in a higher efficiency than that calculated with adiabatic.

The only difference between the two head equations is in the "k" or "n" values. Because of hydraulic losses, the "n" value for the polytropic process is greater than the "k" value for the adiabatic process. The relation between these values is called the polytropic efficiency.

$$EFF_p = \frac{\left(\frac{k-1}{k}\right)}{\left(\frac{n-1}{n}\right)} \quad (4)$$

Where the value of "n" is found by test, using actual pressures and temperatures:

$$\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} = \left(\frac{T_2}{T_1}\right) \quad (5)$$

An unfortunate situation exists in this country in that both compression process calculations, polytropic and adiabatic, are in use. For this reason the efficiencies, heads and other calculations depending on the process of compression, must be properly identified.

The performance of a centrifugal compressor is usually presented in terms of a family of curves that displays graphically the range of flows, efficiencies, heads and speeds through which the compressor is capable of operating. This series of curves is commonly called the "operating envelope." *Fig. 2* is typical of an envelope for a single stage pipeline compressor. The adiabatic head in feet, is plotted against actual inlet flow to the compressor, in ACFM. Normally, the head produced by the machine at various flows is plotted for a constant speed. By varying this speed, it is possible to form a series of head vs. flow curves.

The efficiency of the machine at various heads, flows and speeds is plotted in what appears to be a series of "plateaus" on the "envelope," each line representing a constant efficiency.

The left side of the envelope is bounded by a line that is the low-flow pumping limit or surge line. This line represents the minimum capacity, for all speeds, at which the compressor can maintain stable operation. To the left of the line, at smaller flows, operation of the compressor becomes unstable. This condition is characterized by an audible noise that suggests to an observer that the compressor is "pumping" gas. Actually, the capacity of the unit has been reduced to a point at which the pressure in the discharge line is greater than that produced by the compressor. Under these conditions the gas flow out of the compressor is momentarily stopped, and gas tries to flow back into the machine. As this begins to happen the compressor discharges gas at a higher pressure and a condition of pulsating flow is created.

The right side of the envelope is normally limited at an arbitrary efficiency line. The shape of the speed lines is such that as the flow of the compressor is increased, the head produced is decreased. This applies to all speed lines. Thus, at higher flow rates, the head continues to decrease until a condition occurs that is called "wide-open flow." That is the maximum rate of flow of the compressor.

The top side of the envelope is limited at the maximum speed of the compressor. This limit is actually the maxium safe operating tip speed of the impeller. This is determined from the physical strength of impeller material, and the diameter of the impeller.

The lower side of the envelope is actually not limited by the compressor. If the surge and constant efficiency lines corresponding to the compressor's wide-open flow condition were extended downward, they would converge at zero head and flow. These are the limits within which the unit can operate at reduced speeds. It is from this fact that the centrifugal derives its ability to operate as a variable speed machine. In actual applications the lower speed limit is normally dictated by the prime mover, not the compressor. Thus the limits within which the centrifugal compressor can operate are established as: surge, wide-open flow, maximum tip speed of the impeller, and the lowest permissible operating speed as determined from the prime mover.

It is the duty of the centrifugal designer to design the compressor so that maximum utilization of the compressor can be achieved for a particular application. In order to be able to accomplish this, sufficient information must be supplied concerning the application to establish the design. This information consists of four basic parts:

A. *Gas properties*
   1. Composition
   2. Molecular weight
   3. Ratio of specific heats
   4. Compressibility factors

B. *Section conditions*
   1. Pressure
   2. Temperature
   3. Flow

C. *Discharge condition*
   1. Pressure
   2. Temperature

D. *Prime mover*
   1. Range of speeds available
   2. Range of horsepower available
   3. Climatic condition at which unit is to operate

This information permits the designer to calculate total head and flow requirements that the compressor must satisfy. Generally speaking, centrifugal compressor manufacturers have a number of compressor cases already designed to cover a wide range of flows

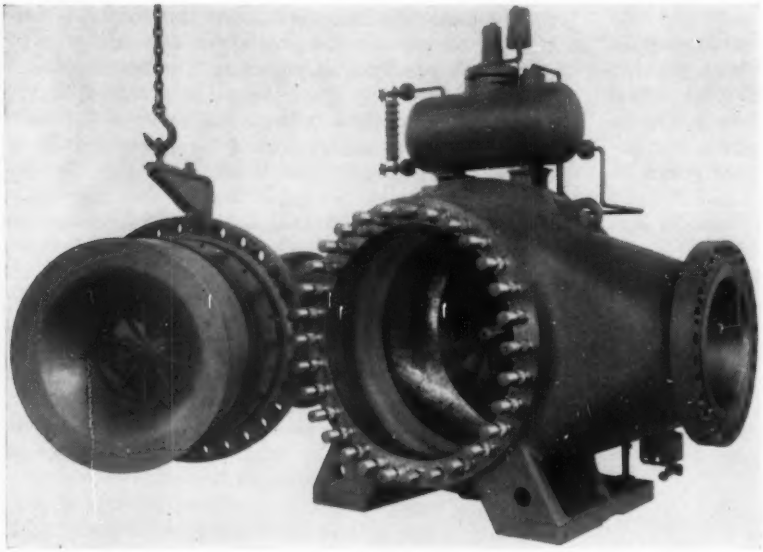


Fig. 3a (below). A cross section drawing of a centrifugal compressor.

Fig. 3b (left). Photo of a standard centrifugal compressor case with part of the internal assembly swung out.

and static pressure levels. The high investment costs in these large castings requires the designer to employ one of the standard cases. The design of the standard case is generally so arranged that the required flexibility in design is achieved by tailoring the other parts within the case to fit a particular application. (See *Fig. 3.*)

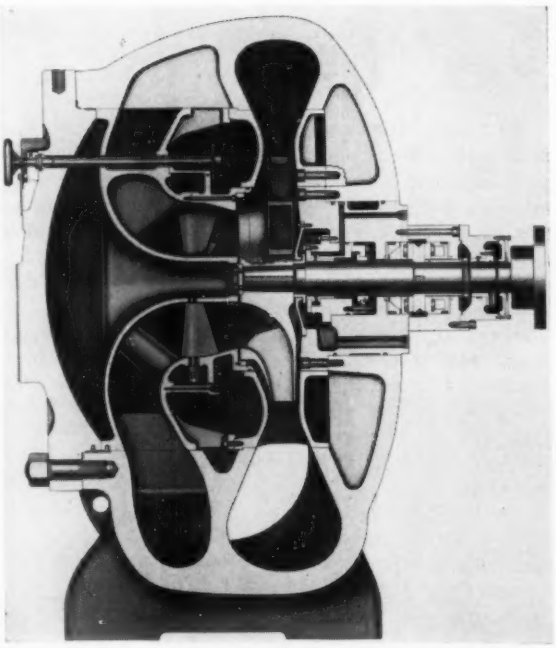
The centrifugal designer has a number of design tools at his disposal. Many of these tools have a theoretical origin, others are experimental. Regardless of the origin, these tools have been extremely useful in correlating the results of countless tests of various types of impellers. (See *Fig. 4.*) The actual design of a centrifugal compressor is beyond the scope of this article. However, the introduction of a few of these design tools is essential to an understanding of operating principles for centrifugal compressors.

The first of these design tools is known as "affinity laws." These laws state the relationship between head, capacity, and brake horsepower in terms of speed, for a given size impeller. Subscript 1 refers to the original speed and Subscript 2 refers to the new speed. Thus:

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2} \qquad \frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2 \qquad \frac{BHP_1}{BHP_2} = \left(\frac{N_1}{N_2}\right)^3 \qquad (6)$$

Where N is the speed in rpm, H is the head in feet, BHP is the brake horsepower, and Q is the capacity in cfm. Similar laws have been developed to compare the performance of two geometrically similar impellers. Through the use of these laws, designers have been able to develop other tools such as the "dimensionless characteristics curves."

This useful tool enables the designer to display the entire "operating envelope" for a compressor on one simple plot. *Fig. 5* is typical of this plot. The horizontal axis represents the dimensionless ratio of capacity in cfm, divided by the compressor speed in rpm. The dimensionless characteristics "head coefficient" and "theoretical head coefficient" are plotted



on the vertical axis along with efficiency. The equation for the head coefficient is as follows:

$$\psi = \frac{Hd \times 32.17}{W^2} \qquad W = \frac{DN}{229} \qquad (7)$$

Where ψ is the head coefficient; Hd is the head in feet; W is the impeller tip speed; D is the diameter of the impeller in inches, whose speed is N in rpm. The theoretical head coefficient is the head coefficient divided by efficiency. The head and efficiency may be expressed as either adiabatic or polytropic.

The "user" of the centrifugal compressor normally employs adiabatic calculations, primarily to establish

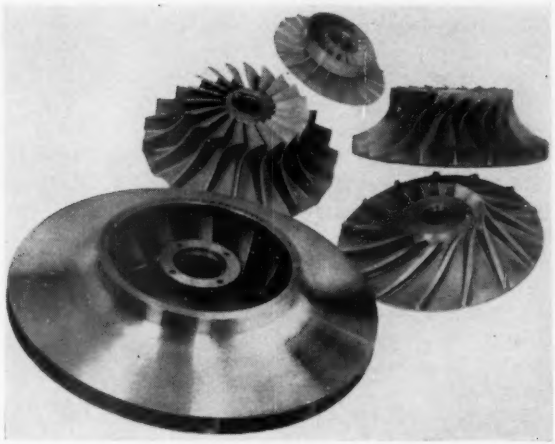


Fig. 4. Several varying designs of centrifugal compressor impellers or "wheel."

a standard against which he may compare performance of several machines from different manufacturers. The designer normally uses polytropic calculations inasmuch as he is trying to predict as closely as is possible the actual performance of his machine. Similarly, capacity of the compressor is taken by the user at the compressor inlet, whereas the designer utilizes capacity of the machine at the compressor discharge. Thus, the designer's characteristic curves are based on polytropic heads and efficiencies with capacities expressed at compressor discharge. For these conditions the designer's characteristics curves are true for all speeds. Inasmuch as the user of the compressor is seeking a standard of comparison only, adiabatic head, and efficiencies, based on inlet capacities, are valid only at one speed, but are approximate at other speeds. Usually this speed is taken as the design speed.

The dimensionless characteristic curves are fundamental to the design of the centrifugal compressor. For any one compressor manufacturer, head coefficients and efficiencies are fairly well established for various values of Q/N. However, compressor manufacturers do not necessarily design their compressors alike. Therefore, head coefficient and efficiencies vary from one manufacturer to another, and sometimes from one designer to another, even for the same manufacturer.

Once a designer has established the design point on dimensionless curves, the operating limits, as previously discussed, are easily determined. Normally, the surge limit occurs at a Q/N that is about 50 per cent of the design Q/N. The "wide-open flow" limit is usually set at a Q/N of about 110 per cent to 125 per cent of the design Q/N. Values for the head coefficient and efficiencies for these limits and the design point are estimated by the designer, from the performance tests of other compressors operating at similar conditions. The design of a centrifugal compressor is firmly established on a sound theoretical foundation, but the skill and experience of the designer and compressor manufacturer are extremely important in translating theoretical design into practical design.

It cannot be emphasized too strongly that it is the responsibility of both the designer and he user of the centrifugal compressor to determine not only all of the data necessary to properly design the unit, but to lay out expansion plans for future use. It is the primary responsibility of users to determine what increased flows are anticipated. A careful engineering study must be made to establish future growth patterns for each application. For pipelines, these growth patterns involve increased flow rates resulting from installation of additional horsepower or a main-line looping program or a combination of the two. Once the expansion program is determined, it is the responsibility of the designer to tailor his designs so that increased flow rates can be efficiently handled.

The method employed by Gulf Interstate Co. clearly

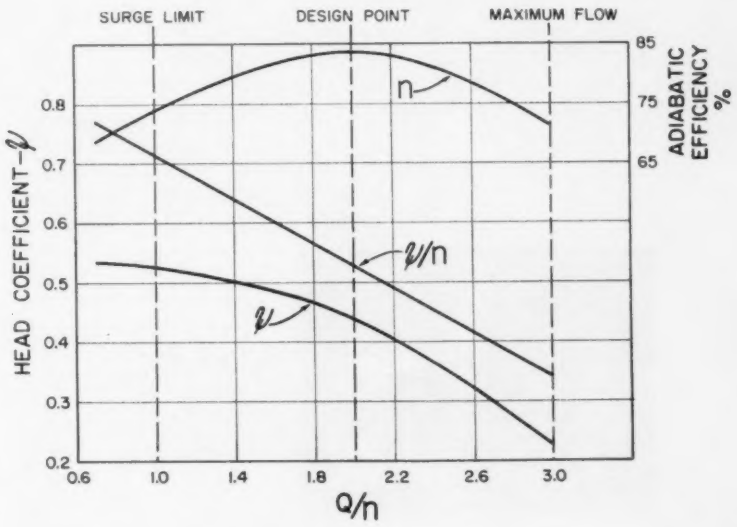


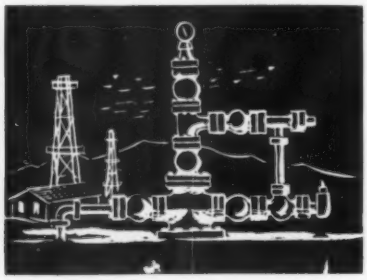
Fig. 5. Dimensionless characteristics for centrifugal compressor.

illustrates the proper method of impeller selections for future increased flow rates. The efficiency curve of the dimensionless plot clearly shows that the compressor is able to produce its best efficiency in a narrow range of Q/N values, centering around the design Q/N. This curve also states that while the unit will operate at other Q/N values, it does so at a reduced efficiency. In many cases, the efficiency reduction can become quite large depending on the actual impeller design and its operating conditions. Thus a good centrifugal design would have a flat but high efficiency curve for the compressor. A flat, high efficiency curve while desirable is not always possible. Since a prudent centrifugal design would incorporate plans for future increased flows, it is necessary to design the required impellers so that they will have overlapping characteristics. Then it would be possible to change out impellers at preselected flows, so that one of the impellers would always be operating at conditions near its best efficiency point.

Figs. 6a, 6b, and 6c illustrate this concept. The impellers involved were those employed on the Columbia Gulf Transmission Co., formerly Gulf Interstate Gas Co. The 29-in. wheel was installed in the first centrifugal unit. It was designed to handle a main line flow of 375 MMcfd. An expansion program involving the installation of one centrifugal unit at each of five locations was completed and the flow was increased to 425 MMcfd. The 27.5-in. unit was so designed that its best efficiency point occurred at the new higher flow rate of 425 MMcfd. The 27.5-in. wheel has the ability to pump not only the lower flows but can reach up to a 500 MMcfd flow rate.

A second expansion program to increase the flow rate was undertaken that required the installation of three additional centrifugal compressors at each of the five previously mentioned stations. This resulted in five centrifugal stations, each consisting of four compressors operating in series. The inlet flow to each compressor in the series decreases as the suction pressure to each unit increases. The total head produced by the units in series is the sum of the individual heads. For these reasons the 23-in. impeller was introduced to handle the low head, higher flow rates.

The impellers were arranged so that suction gas passed from the first 23-in. unit to the second 23-in. unit, then to the first 27.5-in. unit and then into the second 27.5-in. impeller. Thus the 23-in. impellers make up the first and second stages of compression, and 27.5-in. units make up the third and fourth stages.



Each impeller is housed in a separate case. *Fig. 7* shows the gas piping arrangement actually used at a Columbia Gulf centrifugal compressor station. The 23-in. units are designed for future increased flow rates and is the final design impeller. The 27.5-in. units are designed for intermediate flows only.

The third expansion program for the pipeline consisted of looping the discharge side of the stations. The program increased the through put to 575 MMcfd. The 27-5-in. wheels were replaced with additional 23-in. wheels. This arrangement resulted in all four compressors at each station having 23-in. wheels, each in series. As previously mentioned, the 23-in. wheel is the ultimate design for this pipeline system. It is capable of handling flows up to the maximum flow limit of the case, approximately 1000 MMcfd.

At some point in the normal growth pattern of a pipeline, the decision must be reached as to when to begin parallel compressor operations. In the case of the Columbia Gulf system, that point is established at the 750 MMcfd flow. As previously discussed, the first centrifugal unit was installed to handle a flow of only 375 MMcfd. The compressor case for that unit was selected so that the anticipated growth in flow rates could be handled with only minor impeller changes, until the maximum flow limits of the case were reached. Thus a case was selected that had a 1 billion cu ft flow limit, although the actual flow it would handle when first installed was only 375 MMcfd.

To handle flows greater than the case limit, parallel operation is required. For this type of operation, the flow rate would be halved, calling for another impeller change. You will recall that three different impellers have been used on the Columbia Gulf system. As one size impeller was retired from operation, it was carefully stored for future use. Thus the 27.5-in. impeller would now be required for the reduced flow rates for parallel operation. As the flow rate is further increased, the 23-in. impeller would replace the 27.5-in. unit.

The benefits of a planned long range expansion program of centrifugal designs are apparent. The program must begin with the design of the first compressor if the ultimate in flexibility inherent with the centrifugal compressor is to be achieved.

The centrifugal compressor manufacturers in this country offer a wide range of machines. In general these machines are classed as either low or high static pressure units. Within each group, they are further divided as single stage or multi-stage, depending on the total head produced within a case. The low static pressure machines have a light-weight case and are widely used in many so-called "process gas" applications. Many of these machines are perfectly suited for low pressure pipeline service. Pipelines normally require the large high static pressure cases. Both single- and multi-stage units are employed in this service. In general, a single-stage machine is best suited to operate in a range of compression ratios of 1.10 to 1.30 to achieve their best efficiency. These units can operate at ratios up to 1.45, but at a sacrifice in efficiency. At their best operating ratios and flows, the single stage units achieve adiabatic efficiencies in the neighborhood of 82 to 85 per cent.

Fig. 6a, 6b, and 6c (from top to bottom), showing projected long range study to select future impellers for large increase in flows.

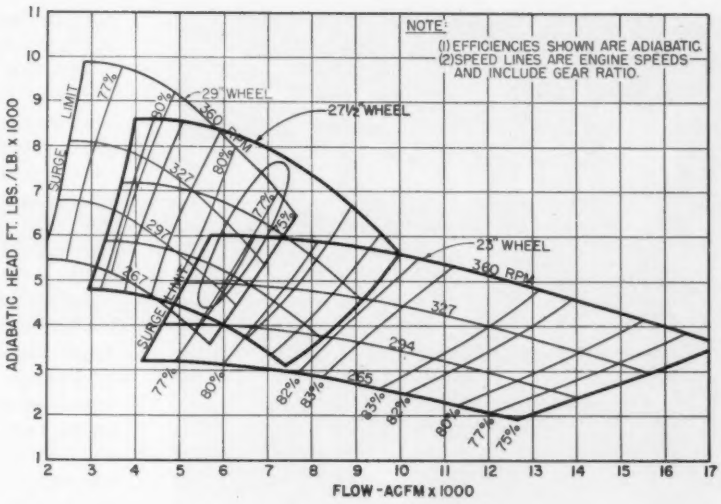


Fig. 6a.

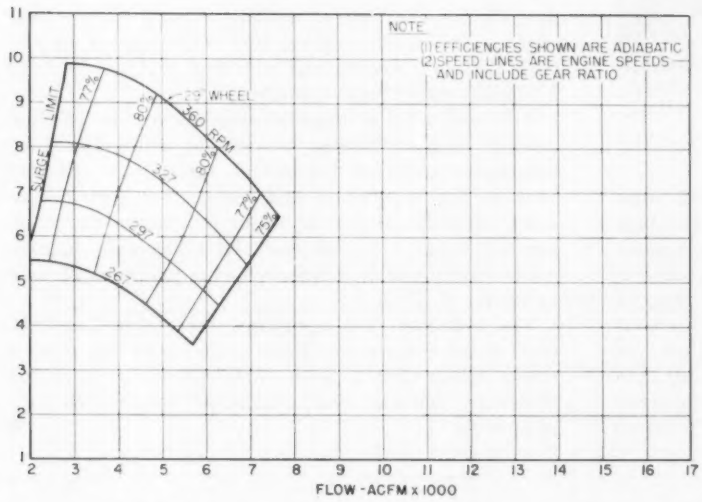


Fig. 6b.

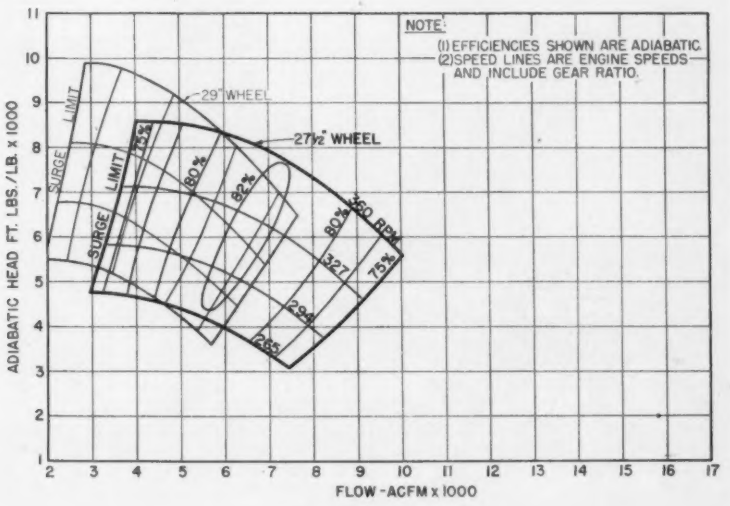


Fig. 6c.

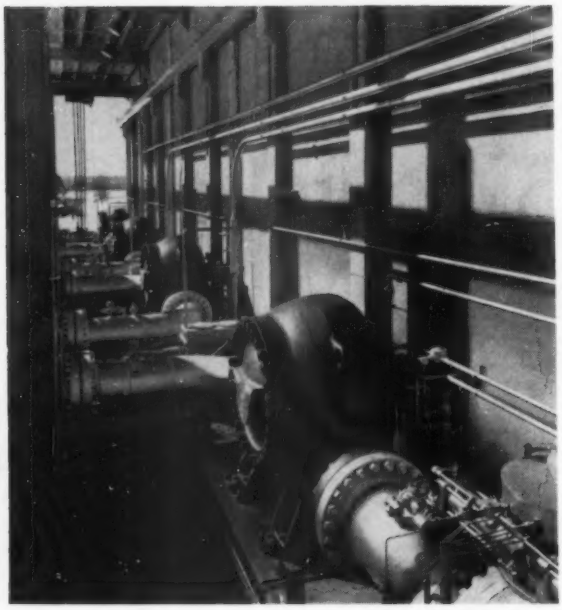


Fig. 7. Gas piping arrangement used at Columbia Gulf centrifugal compressor station.

The multi-stage units normally operate with some overlap in compression ratios with the single-stage units. The multi-stage units begin with ratios of 1.30 and extend on up to about 2.00, with adiabatic efficiencies in the neighborhood of 72-75 per cent, at their design point. All of the multi-stage units are of the barrel type, so named because the impellers are mounted onto a single long shaft. The casing into which they fit is therefore elongated and somewhat resembles a barrel. These units are either horizontally or vertically split, depending on how they are mechanically assembled.

The first pipeline centrifugal compressor was installed at a Texas Eastern compressor station in 1947. This marked the beginning of the rapid development of the centrifugal compressor in pipeline service. Before August of this year, the first all centrifugal compressor pipeline will be placed in operation. This system is the new Transwestern Pipeline now under construction.

The gas industry has come to regard the centrifugal compressor as one of the major factors in providing low cost natural gas service throughout the country. While the centrifugal compressor has found its place in pipeline service, the industry has not yet determined what single prime mover is best suited for mating with the compressor.

All types of prime movers have been employed with the centrifugal compressor. Gas turbines, steam turbines, electrical motors, two-cycle and four-cycle gas engines, all have driven the compressor. More recently an announcement has been made of the immediate construction of a station using a somewhat exotic prime mover combination consisting of an aircraft type jet engine and a power turbine to drive a pipeline centrifugal compressor.

The search for a suitable prime mover for the compressor is a continuing process to select the most economical unit for the actual application. Factors such as fuel, operating and installation costs, reliability or availability, manual or automatic operating, lack of water, etc., all must be thoroughly investigated before the final selection of a prime mover can be made.

The industry now recognizes this basic fact: the centrifugal compressor, when mated with the correct prime mover for a given application, is a highly desirable, reliable, and economical compressor unit to operate. ■

INLET FLOW (ACFM)

$$Q_{IN} = \frac{Q_{STD} \times P_b \times T_{IN} \times Z_{IN}}{1440 \times T_b \times P_{IN}}$$

ADIABATIC HEAD (Ft.-Lb./Lb.)

$$Hd = \frac{R \times T_{IN} \times Z_{AVG} \times \left(\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}} - 1\right)}{\left(\frac{K-1}{K}\right)}$$

POLYTROPIC EFFICIENCY

$$EFF._{POLY.} = \frac{\frac{K-1}{K}}{\frac{n-1}{n}}$$

MASS FLOW (Lb./Min.)

$$m = \frac{Q_{STD} \times Sp.\,Gr. \times M_{AIR}}{1440 \times Mv_{AIR}}$$

ADIABATIC GAS HORSEPOWER

$$GHP_{AD} = \frac{Hd_{AD} \times Mass\ Flow}{33{,}000}$$

ADIABATIC TEMP. RISE EFFICIENCY

$$EFF._{AD} = \frac{\Delta T_{AD.}}{\Delta T_{ACT.}} = \frac{T_{2AD.} - T_1}{T_{2ACT.} - T_1}$$

$$M_{AIR} = 29 \frac{Lb.}{MOL}$$

$$Mv_{AIR} = 371 \frac{Ft^3}{MOL}$$

SHAFT HORSEPOWER

$$S.HP = \frac{GHP_{AD.}}{\eta_{AD.} \times \eta_{MECH.\,COMP.}}$$

PRESSURE AND TEMP. RELATIONSHIP

$$\left(\frac{P_2}{P_1}\right)^{\left(\frac{n-1}{n}\right)} = \frac{T_2}{T_1}$$

Fig. 8. Summary of equations—centrifugal compressors.

Here is a supplementary report on

Pipeline flow tests

IN August, 1959, GAS published details of a series of flow tests conducted in 1958 on a 12-mile section of 24-in. OD x .250-in. WT pipe. The goal was to determine if interior cleaning or internal coating of the pipe had any effect on pipeline deliverability.

In December, 1959, the same section of line was re-tested, reported on here by C. H. Klohn of Tennessee Gas Pipeline Co. A range of flow rate was established from 150 MMcfd to 450 MMcfd, in increments of approximately 50 MMcfd.

THE degree of stability obtained at the higher rates of flow was not as good as the 1958 tests. Pressure variations in most cases were 0.2 psi between the 5-minute readings. However, pipeline pressure differential remained fairly constant.

Stability was best at the two low rates of flow, and results reproduced those obtained in 1958. At the higher rates, however, both upstream and downstream

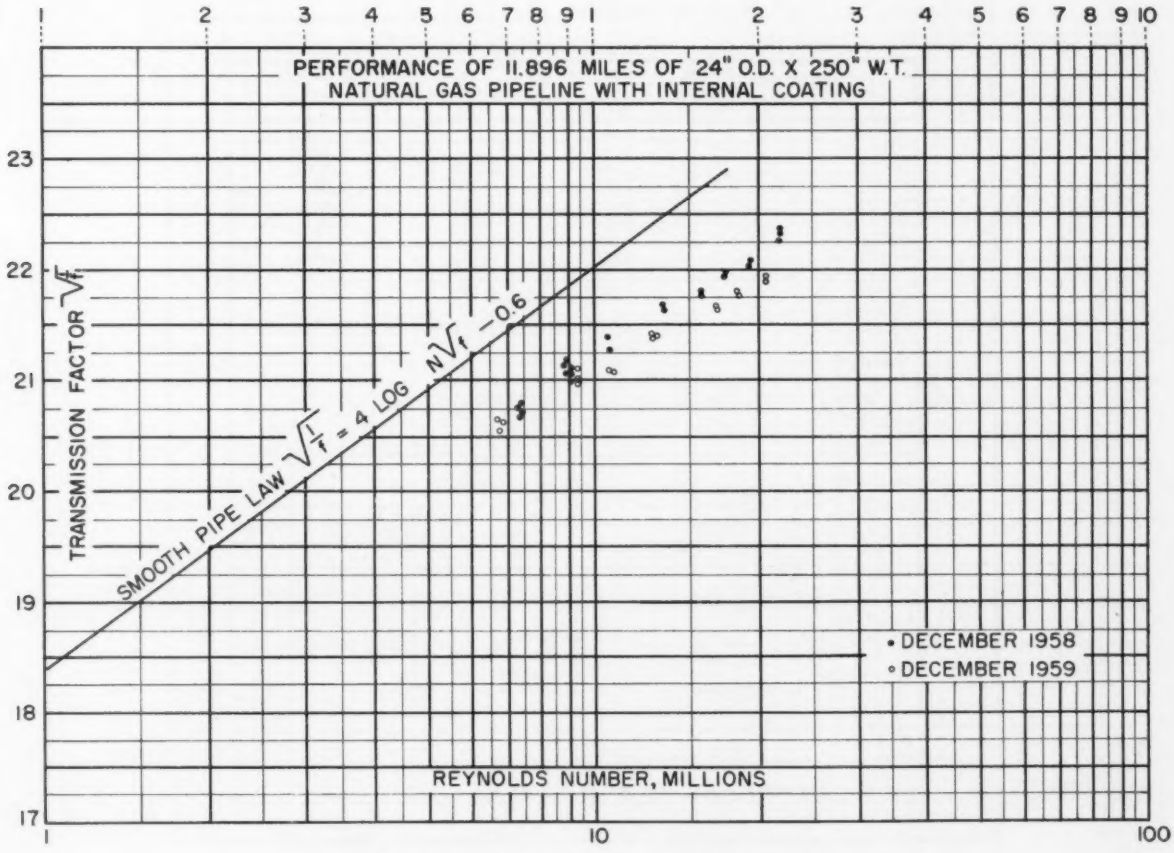

PERFORMANCE OF 11.896 MILES OF 24" O.D. X 250" W.T.
NATURAL GAS PIPELINE WITH INTERNAL COATING
TRANSMISSION FACTOR $\sqrt{F_t}$
SMOOTH PIPE LAW $\sqrt{\frac{1}{f}} = 4 \log N\sqrt{f} - 0.6$
• DECEMBER 1958
◦ DECEMBER 1959
REYNOLDS NUMBER, MILLIONS
1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 10
23 22 21 20 19 18 17
1 10 100

Fig. 1. Transmission factor vs. Reynolds number.

pressures were consistently rising, which would tend to produce a lower-than-true transmission factor, since measurement facilities are downstream.

Fig. 1 shows the transmission factors computed for the 1958 and 1959 tests. The 1959 tests are approximately 1 per cent lower at the higher rates of flow. Part of this 1 per cent may be attributed to the different degrees of stability attained.

The conclusion may be reached that the 1958 test results were reproduced within a very close tolerance of experimental error, and from this it can be concluded that there has been no apparent deterioration of the interior coating. ■

INDICATIONS OF GAS QUALITY, 1959 TESTS

TEST NO.	WATER CONTENT #/MM	HYDROCARBON D.P. °F	PRESSURE PSIA
1-A	2.8	54	625
1-AR	2.9	58	620
1-B	2.1	49	605
1-C	2.7	52	605
2-A	3.0	54	630
2-2B	3.5	54	630
2-C	3.9	58	640
3-A	2.0	50	670
3-AR1	2.7	52	670

TENNESSEE GAS PIPELINE COMPANY
DIVISION OF TENNESSEE GAS TRANSMISSION COMPANY

GAS SAMPLE ANALYSIS

PRODUCER: Tennessee Gas Pipeline Company ANALYSIS DATE: 1-15-60

LOCATION: M.L.V. #6 Refugio Test Site

STATION NUMBER (COLS. 1-6): _____ COMPOSITE CODE (COL. 7)*: _____

ANALYSIS	COLS. 8-9 ANALYSIS CODE	COLS. 10-15 MOL. FRACTION	GPM 14.696 PSIA @ 60° F	SP. GR. @ 60° F (AIR = 1)
CARBON DIOXIDE	01	0.0035		0.0053
NITROGEN	02	0.0070		0.0068
METHANE	03	0.9474	16.057	0.5258
ETHANE	04	0.0310	0.788	0.0324
PROPANE	05	0.0072	0.197	0.0111
ISO-BUTANE	06	0.0013	0.043	0.0027
N-BUTANE	07	0.0012	0.038	0.0025
ISO-PENTANE	08	0.0003	0.011	0.0008
N-PENTANE	09	0.0004	0.014	0.0010
HEXANES +	10	0.0007	0.029	0.0022
HEPTANES PLUS	11			
TOTAL		1.0000	17.177	0.5906

*COMPOSITE CODES:
1 - GREEN BRANCH LINE
2 - 16" VALLEY LINE
3 - DEAN (1+2)
4 - 26" VALLEY LINE
5 - SOUTH LOUISIANA LINE
6 - MAIN LINE TOTAL

FIELD DATA:
PRES. 595 PSI
TEMP. 67 °F
SP. GR. 0.593
H2O D. P. -3 °F @ 595 PSI
HYD. D. P. 50 °F @ 595 PSI
BTU
SAMPLE Natural Gas
TAKEN BY Wilson
DATE 12-8-59
BOMB NO. E 8447

LAB. DATA:
ANALYSIS NO. 1905
DEV. TEST NO. 4588
ANALYSIS BY C. E. Richardson
SP. GR. (BAL.) 0.593
SP. GR. (CALC.) 0.591
BTU (DRY) ** 1049
BTU (WET) ** 1031
BTU (DETERMINED)

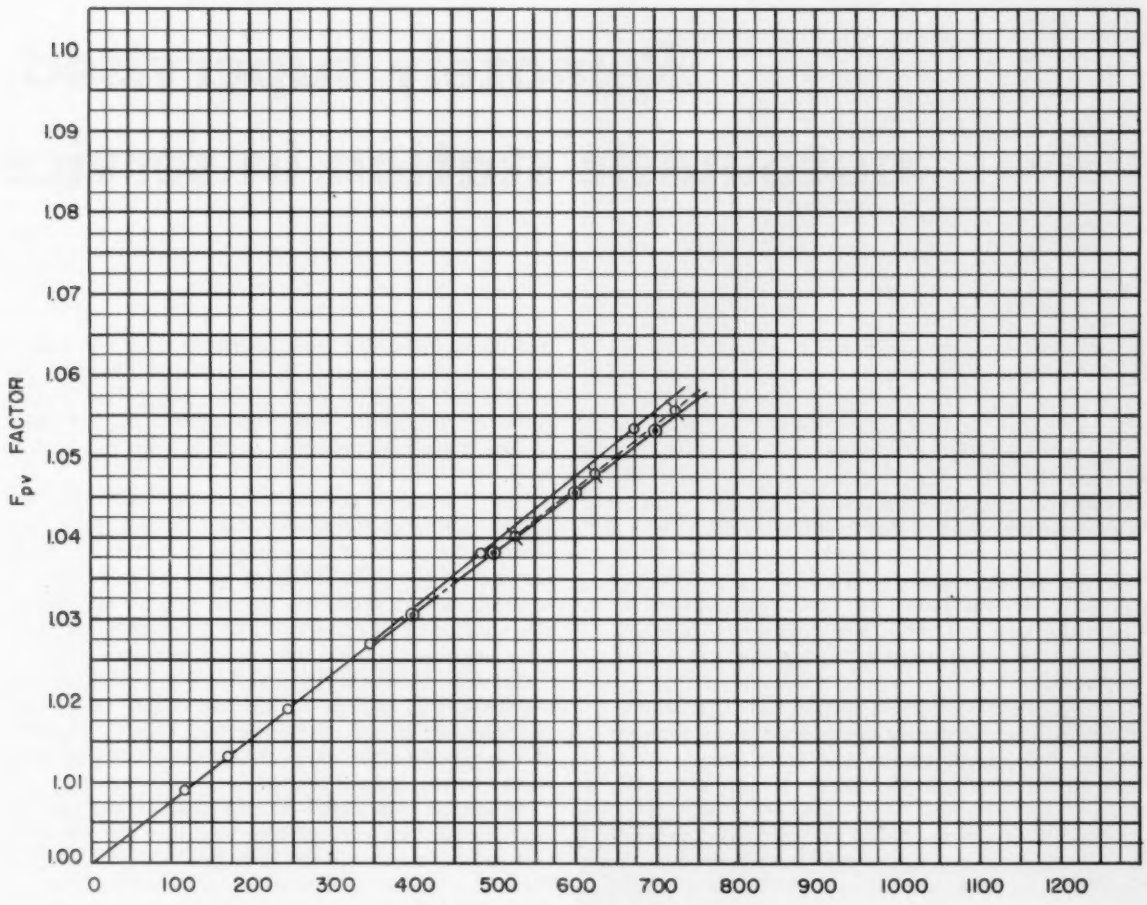
REMARKS: **BTU/cu. ft. at 14.73 PSIA at 60° F

DP - Press. 595 DP -3 = 2.25# H_2O

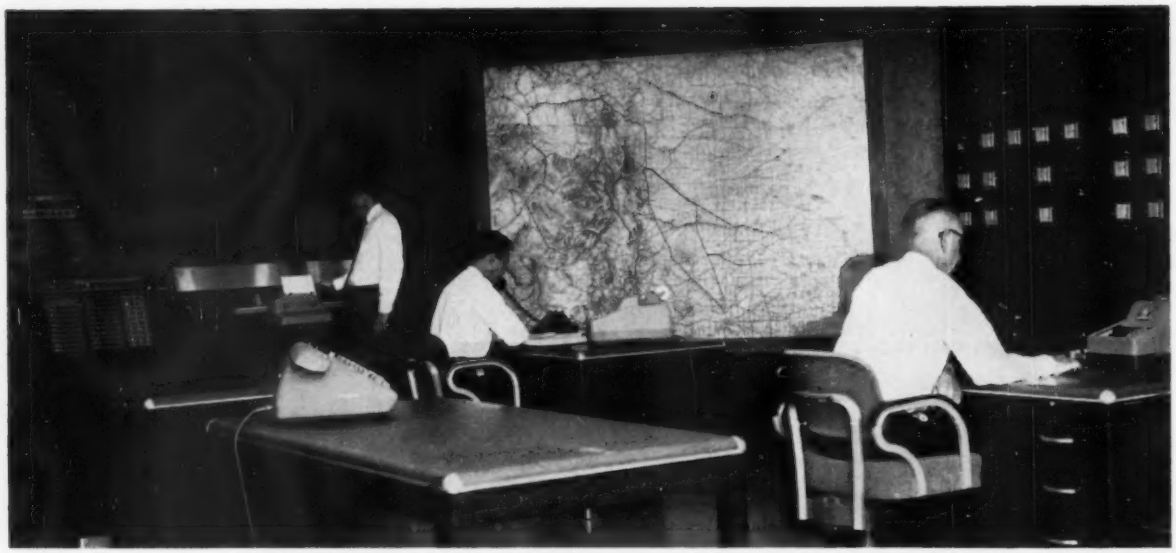
Typical gas analysis

1959 TESTS—SUMMARY SHEET

Test	Date	Starting Time	P_1 PSIA	P_2 PSIA	dp_c	Qm MMcfd	G	T_1 °F	T_2 °F	Average $\frac{1}{z}$	f	Viscosity $M \times 10^6$	$N_R \times 10^{-3}$	$\sqrt{\frac{1}{f}}$	Darcy Coefficient f_c
1-A	12- 7-59	2:45	649.86	630.61	0.26	202.06	.597	68	67.5	1.0960	.002247	7.70	9,196	21.10	.008988
1-AR		4-35	646.23	625.90	.26	206.22	.595	68	67	1.0955	.002273	7.69	9,366	20.98	.009092
1-AR1		5:20	645.71	625.37	.26	206.30	.595	68	67	1.0955	.002270	7.69	9,370	20.99	.009080
1-B	12- 8-59	10:25	637.16	610.96	.25	234.41	.593	68	67.5	1.1007	.002249	7.67	10,638	21.09	.008995
1-BR		10:55	637.83	611.57	.25	234.87	.593	68	67	1.1022	.002251	7.67	10,659	21.08	.009006
1-C	12- 8-59	2:05	650.22	614.62	.26	278.93	.594	68	66.5	1.0948	.002178	7.68	12,663	21.43	.008713
1-CR		3-25	650.77	615.21	.26	278.72	.594	68	66.5	1.0948	.002181	7.69	12,637	21.41	.008724
1-CR1		3:50	651.63	615.90	.26	279.30	.594	68	66.5	1.0953	.002186	7.69	12,664	21.39	.008746
2-A	12- 9-59	1:25	699.35	641.75	.27	370.10	.596	68	66	1.1005	.002133	7.73	16,750	21.65	.008533
2-AR		2:00	700.14	642.49	.27	370.31	.596	68	66	1.1011	.002136	7.73	16,760	21.64	.008545
2-B	12- 9-59	3:55	708.30	640.66	.28	405.26	.596	68	65	1.1012	.002106	7.73	18,342	21.79	.008424
2-BR		4:20	709.17	641.33	.28	405.41	.596	68	65	1.1012	.002113	7.73	18,348	21.76	.008452
2-C	12-10-59	1:35	730.23	649.71	.28	450.29	.598	68	65	1.1057	.002080	7.75	20,395	21.93	.008321
2-CR		2:05	731.43	650.60	.28	450.62	.598	68	65	1.1057	.002088	7.75	20,410	21.88	.008354
3-A	12-11-59	10:25	687.49	677.25	.28	148.05	.600	68	65.5	1.1043	.002350	7.75	6,728	20.63	.009402
3-AR		10:50	687.02	676.86	.28	147.46	.600	68	65.5	1.1043	.002349	7.74	6,710	20.63	.009395
3-AR1		11:45	686.84	676.59	.28	148.02	.600	68	66.5	1.1043	.002351	7.74	6,735	20.62	.009405
3-AR2		12:10	687.12	676.72	.28	148.49	.600	68	66.5	1.1043	.002373	7.75	6,748	20.53	.009490



Typical results of supercompressibility tests



Portion of Interstate's communications control center. Control console and monitor for the automatic control system is located at the left rear.

Remotely supervised, automatic station in service

THE first remotely supervised automatic compressor station for a gas transmission company is in operation. The system, belonging to Colorado Interstate Gas Co., is in Interstate's communications control center in Colorado Springs. It supervises the Springfield compressor station, located about 160 miles away.

Participating in the button-pushing ceremony which launched formal use of the control system was N. B. LauBach, vice president in charge of operations for Interstate. He was joined by G. A. Peck, president of Southwestern Industrial Electronics Co., Houston. SIE was the prime contractor for the automation system.

The 7-year-old Springfield station has four Cooper-Bessemer two-cycle engine compressor units totaling 5400 hp. Springfield pumps gas from Texas, Oklahoma, and Kansas into the Rocky Mountain market area.

Normal procedure to effect a change in station pressure calls for the gas dispatcher, located at the control center, to relay his instructions to crews which man the compressor stations on a 24-hr basis. These crews make the needed adjustments manually.

With the automatic control system, Interstate's gas dispatchers can now telemeter over microwave communication channels the discharge pressure figure, or set point control, to the compressor station set point controller. This then resets the set point of the discharge pressure controller at the desired level.

The discharge pressure controller compares the actual discharge pressure with the set point and changes the speed of the engines in service to obtain the correct pressure. If the speed range is insufficient to meet the set point, the engine selector will adjust the number of engines running by starting or stopping engines through the engine sequence controls.

Changes in discharge and suction pressures and the number of engines on line are visible on the station monitor at the control center. This information also is typed out on an electronically controlled typewriter in the control center.

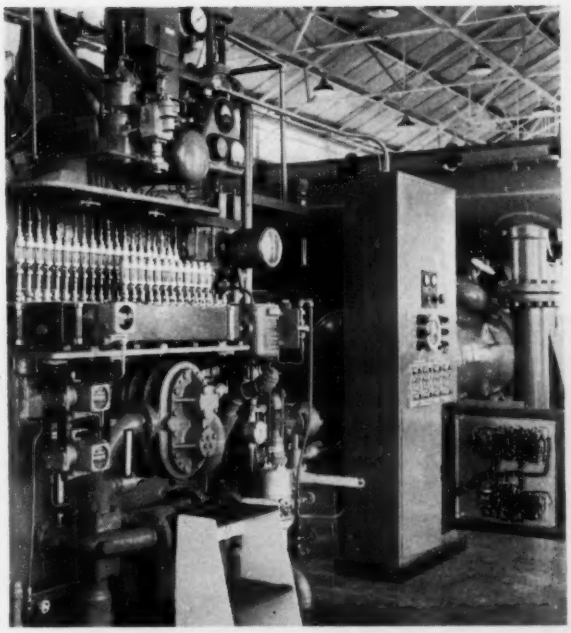
Automatic equipment at the station controls all engine functions necessary to maintain the set pressure point. In addition to the engine control functions, there is a system that monitors all significant conditions requisite to safe operations.

Protective circuits have been provided with the thought in mind that if an operator in his routine

TOP TO BOTTOM—
Power-packed compressor engines at Interstate's Springfield station now are governed by an automatic control system. Engine control panel shown here is one of four ready for duty.

N. B. LauBach (left), Interstate vice president, and G. A. Peck, SIE president, discuss operation of remotely supervised automatic station.

Concrete block building at left houses controls for automatic operation of Springfield. Microwave tower is communication link with main office, 160 miles away. Main compressor building is at right.



duties would observe an "off-limits" condition, a protective device should be provided to detect the same condition.

In most instances, instruments will detect off-limit situations faster and more accurately than a human operator. The design of Interstate's equipment takes full advantage of this. When any of these protective devices is activated, the proper engine or, if necessary, the entire station, is shut down. At the same time, an alarm is signaled to the maintenance staff and the time and identification of the fault are recorded in an automatic log. The log also records each normal start and stop.

Digital telemetering, using solid state electronics equipment, is used in Interstate's control system. This marks the first use of solid state electronics for natural gas compressor station control. This equipment was engineered and designed by SIE to Interstate's specifications. Engine start and stop sequencing equipment was designed by Stearns-Roger Manufacturing Co. and manufactured by SIE. Cooper-Bessemer made necessary modifications on the compressors in order to make them compatible with the control system.

LauBach pointed out the major differences between Interstate's automatic supervisory control and a remote control operation: All station regulating functions, including engine selection, are under the direction of controls located within the station. In a remote control operation, these functions are handled by the dispatcher.

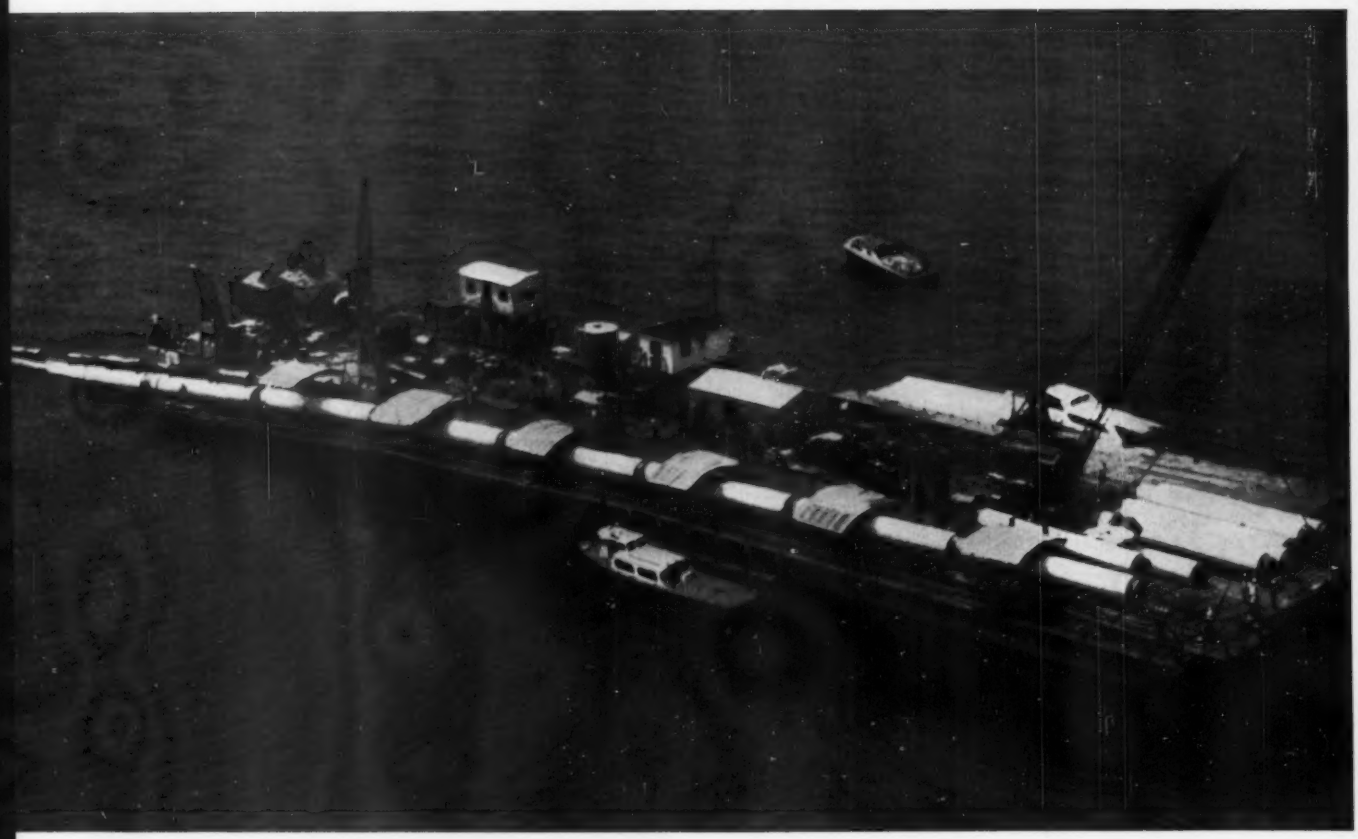
Installation and use of the automatic control system climaxes years of study by Interstate to determine the place of automation in the operations of a gas transmission system.

LauBach explained that inauguration of this system is another step in the evolutionary development of Interstate's facilities, designed to provide better, more efficient and more economical natural gas service.

"We feel that the maximum automation practicable is that degree . . . which brings about the maximum utilization of equipment and personnel at the lowest overall cost of service."

Interstate plans to use the same type of automatic control at the new stations proposed in its $91 million expansion program now awaiting FPC decision. ■

On the Job with Bethlehem Line Pipe



IN VENEZUELA—Forty-inch line pipe—some 12 miles of it—now lies as deep as 100 feet under the surface of Lake Maracaibo, helping to supply gas to one of Creole Petroleum Corporation's re-injection systems. The pipe was made by Bethlehem and supplied to the contractor, Brown & Root, Inc., in 40-ft lengths, each of which, when weighted with a 6-in. coat of mesh-reinforced concrete, tipped the scales at nearly twenty tons.

Steel

For strength
...economy
...versatility

	ELECTRIC FUSION-WELD	ELECTRIC RESISTANCE-WELD	CONTINUOUS BUTTWELD
SIZES (in., OD, incl.)	18 to 42	5⅝ to 16	½ to 4½
WALL THICK-NESS (in.)	¼ to ¾ incl.	API	API
LENGTHS	40 ft★	to 60 ft	SRL 24 to 26 ft DRL to 50 ft
SPECIFI-CATIONS	API 5LX, Grades X42, X46 & X52 Also X-56	API 5L, Grades A & B API 5LX, Grades X42 & X46	API 5L

★Made with 40-ft plates; submerged-arc-welded; hydraulically, expanded.

Bethlehem's new pipe mills at Steelton, Pa., and at Sparrows Point, Md., are turning out more pipe than ever before. And it's pipe of consistent top-quality, too—every length straight and true to round and bevel, and right up to specs.

It's easy to check all the facts about Bethlehem Line Pipe—just call the Bethlehem sales office nearest you.

IN PENNSYLVANIA—New gas service was brought into Carbon County recently when the Pennsylvania Gas Management Co. ran an 8-in. line to Lehighton from Transco's 24-in. main line at Saylorsburg. In spite of the winter and the rough terrain, McKenzie Construction Co., Inc. had no trouble laying the Bethlehem electric resistance-weld pipe. As supplied by C. J. Rainear & Company, Inc., the pipe measured up to specs in every way.

IN ARKANSAS—The latest addition to Arkansas-Louisiana Gas Company's extensive pipeline system is a 100-mile, 16-in. OD transmission line running across the summit of Magazine Mountain, the highest peak in Arkansas. The Bethlehem pipe in this line was furnished in .250-in. wall to API 5LX, Grade X-46 specification, and is now carrying pressures up to 1000 psi.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

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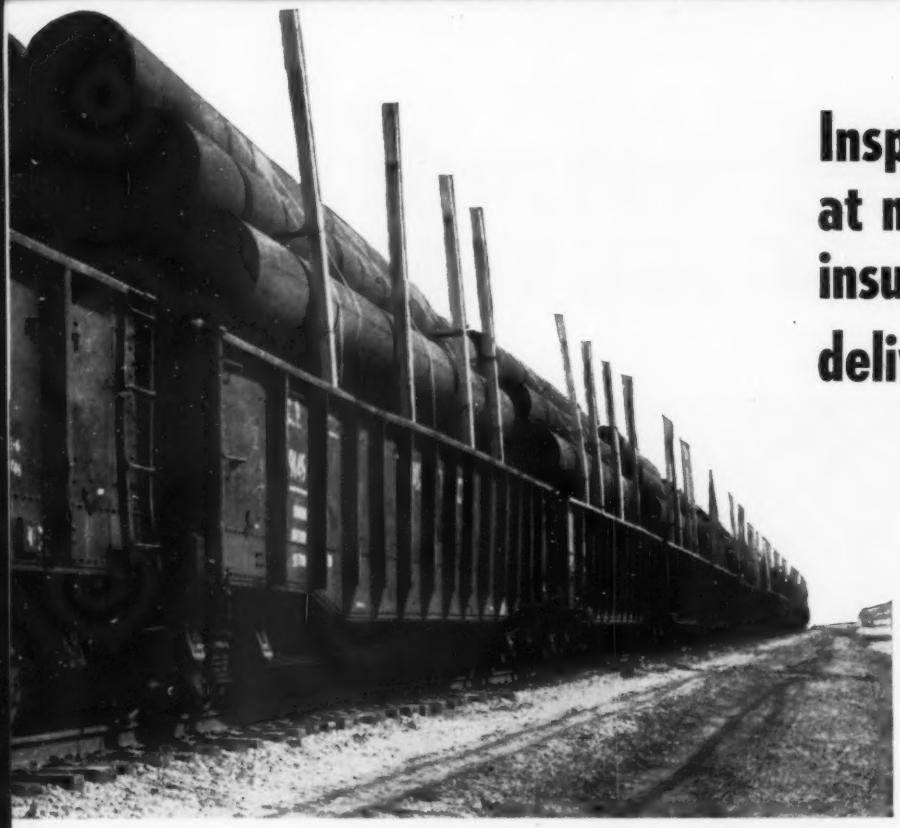
BETHLEHEM STEEL



Inspection practices at mills insure quality of delivered pipe

By N. K. SENATOROFF,
Supervisor of Technical Services
Pacific Lighting Gas Supply
Co., Los Angeles

FEW will disagree that pipeline design and manufacture are becoming increasingly complex. Expanding economy has meant a stepped-up demand for steel plate—almost all of a high-strength grade—by the oil and gas industries. This calls for closer, more stringent inspection by purchasers to assure quality of the product.

With a backlog of orders and with mills working at three-shift capacity, plus the critical chemistry of high strength grade steel, inspection procedures at the mill should cover three phases:

1. Preliminary exploratory inspection of fabricating facilities and quality control instrumentation.
2. Material specimen control tests.
3. Inspection of the finished line pipe.

• Preliminary exploratory inspection

This phase should take place before invitations to bid are mailed to prospective fabricators. The customer's future inspection service should learn about the available fabricating equipment, manufacturing techniques, plant capacity, production rates, and testing procedures of each mill willing to bid on the order. Obsolescence, fabricating limitations, inadequacy of instrumentation for quality control should be uncovered.

The alternative to such a preliminary inspection: disappointment stemming from subsequent makeshift manufacturing compromises and uncertainty about the quality and uniformity of standard of finished pipe.

• Material specimen control

Once an order for pipe has been let, the inspection service becomes an "eye witness." It must see that materials used conform to chemical and physical requirements of the specifications. Also that specified tests such as ladle and check analyses are adhered to. If the check analysis does not meet specified permissible variation, the inspection service should be directed to launch additional tests that may be required for rejection or only partial acceptance of the entire "heat."

Inspection should also include examination of mill-control check analyses. These are made by both the plate and the pipe mill to assure that steel at each stage of production has consistently met the purchaser's specifications. For this information, the inspection service should use the facilities of production control labs available at both mills:

(1) Physical property tests shall include testing tensile strength of both plate and fabricated pipe.

(2) Tensile tests are performed on longitudinal and transverse specimens of designated dimensions of width and gauge length, taken from specified locations.

(3) Transverse tensile test specimens from seamless pipe may be taken from any location. Transverse body-test specimens from welded pipe are taken opposite the weld, or, at the manufacturer's option, from the skelp.

(4) Transverse weld test specimens are taken from the weld at the center of the specimen and tested for tensile strength only.

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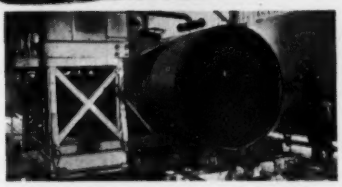
The protection of pipe lines is a major concern with Nicolet Industries. Every product that bears the name of Nicolet is the finest of its kind. That is why NICOLET ASBESTOS PIPE LINE FELTS and NICOLET "OLD NIC" GLASS WRAP are so widely used and specified.

And, that is why so many forward looking Mill Wrap operations rely heavily upon Nicolet Pipe Wraps.

We are proud of the important part we play in the complete pipe protection provided by the better Mill Wrap and Over-The-Ditch operators.

To continue to merit the confidence placed in Nicolet Pipe Line Felts and Glass Wrap, Nicolet maintains the most rigid of Quality Control Systems. From our Asbestos Mines to finished product, you are assured of complete adherence to specifications.

More and more Corrosion Engineers are specifying Nicolet Asbestos Pipe Line Felts and Nicolet "Old Nic" Glass Wrap. You, too, should write today for samples and specifications.



Mill wrapping with Nicolet Felt at Pipe Protection Service, Inc., Kearny, N. J.

72" pipe wrapped with Nicolet Felt by Pipe Protection Service, Inc.

Nicolet Industries, Inc., Florham Park, New Jersey

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(5) All tensile tests include yield strength, tensile strength and elongation determinations.

For submerged-arc welded pipe, the pipe mill must perform either a tensile-elongation test or a guided bend test—at its option. For the latter, one face-bend and one root-bend, both conforming to exact dimensional requirements of the specimen and to the guided-bend test jig dimensions, should be taken.

• Inspection of the finished line pipe

This phase should go beyond checking dimensions, weights and lengths for joints of pipe as specified on the purchase order. It is true that Section VI of the "API Specification for High-Test Line Pipe" attaches great importance to the need of complying to these dimensional requirements. But the buyer's inspection service should not limit itself to a "go and no go" checking. Broad tolerances on dimensions, weights and lengths set forth in the API Specification indirectly create a climate for such attitudes. For example, here are some of the requirements taken from the API Specification:

Outside Diameter, D, all sizes—Tolerance: ±1 per cent. At the option of the manufacturer, the minimum outside diameter of pipe in sizes 20 in. and smaller may be measured with a diameter tape. Pipe 22 in. and larger shall not be more than 0.0312 in. (1/32) in diameter smaller nor more than 0.0937 in. (3/32) larger than the tabulated outside diameter for a distance of 4 in. from the end of the pipe as measured with a diameter tape.

Wall thickness, t, Tolerance:

For pipe in sizes 18 in. and smaller, +15.0 per cent, —12.5 per cent.

For pipe in sizes 20 in. and larger, + 15.0 per cent, —10.0 per cent.

Weight:

Single lengths—all sizes in regular weight series, +10.0 per cent,

Carload lots—all sizes, —3.5 per cent, —1.75 per cent.

Pipe Ends: Unless otherwise ordered, pipe covered by the Specification shall be furnished with ends beveled to an angle of 30 deg., +5 deg., —0 deg . . . and with a root face of 0.0625 (1/16) ±0.0312 (1/32) inches . . . both ends of submerged arc welded pipe shall have the inside weld reinforcement removed for a distance of approximately 4 in. from the end of the pipe.

Workmanship: The finished pipe shall be reasonably straight and free from injurious defects. Pipe shall contain no dents greater than 0.25 in. . . . the length of the dent in any direction shall not exceed one-half of the pipe diameter . . . defects in seamless pipe or in the parent metal of welded pipe shall be considered injurious when depth of defect is greater than 12.5 per cent . . . all cracks, sweats, leaks, or other defects in welds shall be considered injurious. All end welding of longitudinal seams of submerged arc welded pipe, if not done by automatic submerged arc welding, shall be done by a procedure and welder qualified in accordance with Appendix B.

Repair of Defects: The repair of injurious defects shall be permissible on approval of the purchaser's inspector, if the purchaser is so represented; otherwise at the discretion of the manufacturer. However, the repair of defects in the parent metal of welded pipe is not permissible if the depth of defect exceeds 33.33 per cent of the tabulated wall thickness of the pipe, and the length of that portion of the defect in which the depth exceeds 12.5 per cent is greater than 25 per cent of the tabulated outside diameter of the pipe, or if more than one repair is required in any length equivalent to 10 times the tabulated outside diameter of the pipe. . . . Repairs shall conform to the following requirements:

a. The defect shall be completely removed and the cavity thoroughly cleaned.
b. The repair weld shall be made by either automatic or manual submerged arc welding or by manual metallic arc welding using coated electrodes.
c. Each length of repaired pipe shall be tested hydrostatically.

Marking: Pipe manufactured in conformance with this Specification shall be marked by the manufacturer as specified hereinafter. . . . Manufacturer's Name, API Monogram, Size, Weight per Foot, Grade, Process of Manufacture, Type of Steel, Length, Test Pressure.

The remarks made about broad limits in API Specification should not be considered as a criticism. This Specification was never intended to cover anything more than the minimum requirements.

The prudent purchaser should write into his order specifications for pipe more stringent than those called for by API. While he may have to pay some premium, it is felt that it is well justified.

Hydrostatic tests are, to a greater extent than any other mill inspection test, left in the hands of the mill's production department. But the inspection service should assure itself that the API Specification is adhered to as follows:

(1) Each length of pipe shall withstand, without leakage, a mill inspection hydrostatic test to at least the pressure specified.

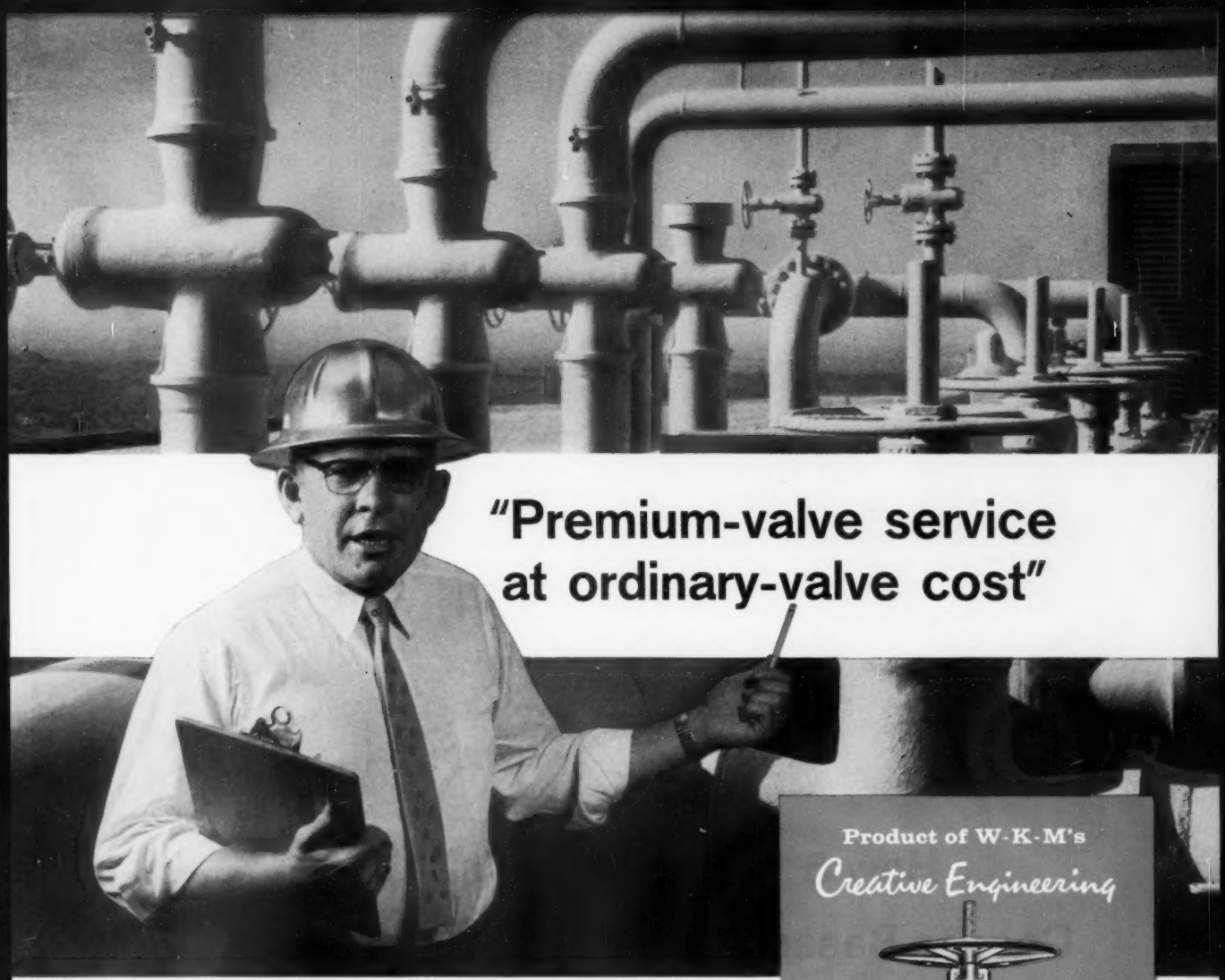
(2) Test pressures for welded pipe in sizes 20 in. and larger shall be held for not less than 10 seconds.

(3) Welded pipe shall be struck while under pressure with a 2-lb hammer or its equivalent, near the weld at both ends of the pipe.

It is always the inspection service's prerogative to request a re-test of a portion or of all pipe in a lot if there is any doubt about the mill test pressure, or facilities, or the mill's adherence to specified requirements. At times when inspectors are unable to witness hydrostatic tests, they should ask to have made available to them the recording pressure gauge charts and calibration dates of gauges.

• Non-destructive tests

The test data taken by the manufacturer during any of the non-destructive tests should always be available to the inspection service. These may include radiographing, fluoroscopic devices, dye penetrant, magnetic particle examination, or sonic instrument and thickness gauge applications. However, the



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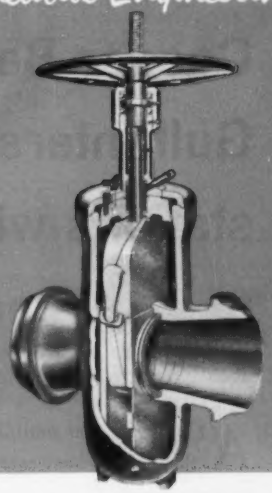

Cylindrical instead of rectangular opening means less pressure drop, less turbulence. W-K-M Venturis feature: ***controlled force seating,*** exclusive gate centralizing mechanism, superfinished stems, seating surfaces sealed from lading flow.

Pressure Ratings: ASA 300 through ASA 1500 lbs. Sizes 3" through 36".

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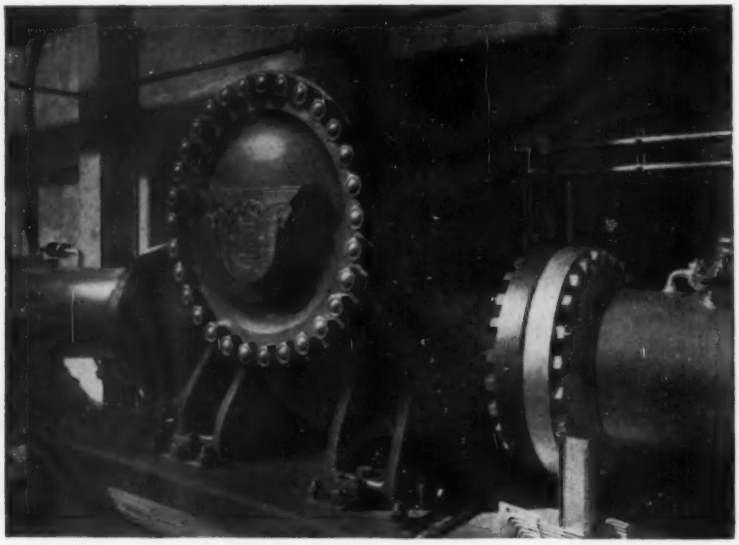


Cooper-Bessemer RFB-24 centrifugals, like this one, powered by Cooper-Bessemer LSV turbocharged gas engines, comprise the world's most efficient pipeline compressor units.

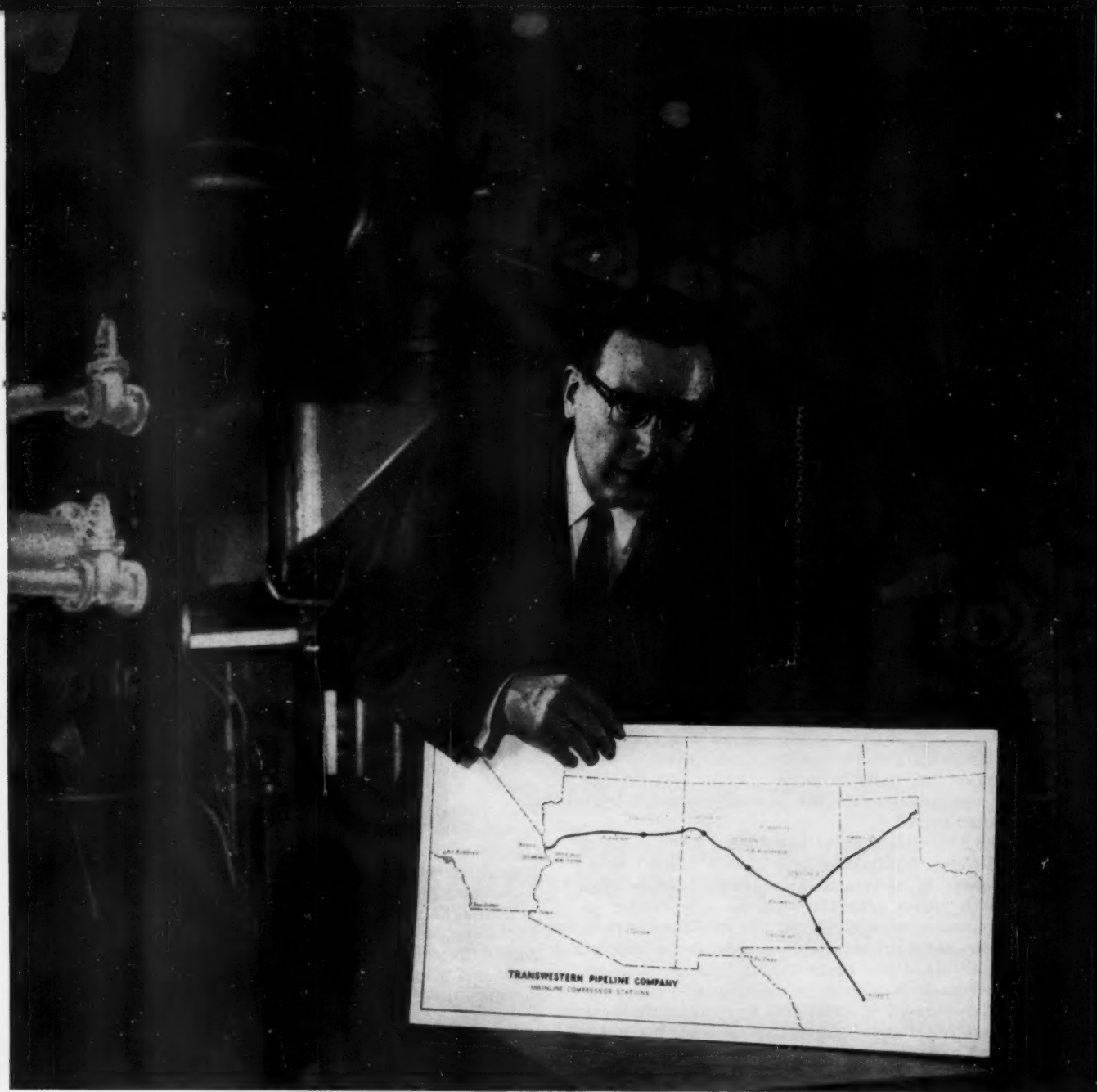
David M. Salls, *Manager, Gas Industry Sales, The Cooper-Bessemer Corporation, explains...*

How 5 Cooper-Bessemer powered, Gulf Interstate engineered stations will give Transwestern peak economy and flexibility

ALL FIVE of the mainline compressor stations of the new Transwestern Pipeline system will be equipped with Cooper-Bessemer engine-driven centrifugal compressors and will be remotely operated. These new automatic, remote-controlled stations will provide unexcelled efficiency and flexibility... a fact proven by the highly successful performance record of this modern equipment in other mainline stations of the same basic design—over 130,000 horsepower to date in mainline service.

The giant Cooper-Bessemer LSV-16 turbocharged gas engines will be of the type shown here. They will drive Cooper-Bessemer RFB-24 centrifugal boosters through speed increasers. Each of the five stations will include two of these high-efficiency compressor units. These units have the highest thermal efficiency obtainable in the gas industry today. The map shows the location of the stations. All units will be automatically controlled from a central point.

We will gladly supply details on this Cooper-



Map shows location of Transwestern's mainline automatic, remote-controlled stations. Background shows type of Cooper-Bessemer LSV-16 turbocharged engines to be used on this new line.

Bessemer equipment, and assist in *your* compressor station plans.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester Pittsburgh • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans • Shreveport • Houston • Greggton • Dallas • Odessa • Pampa Casper • Seattle • San Francisco • Los Angeles

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availability of such test data is not mandatory, if the purchase order does not specifically mention them as required.

• Miscellaneous special items

Inspection and rejection; car or truck loading; stockpiling; communication: As called for in the API Specification, inspection service representing the purchaser shall have free entry at all times—while work on the contract of the purchaser is being performed—to all parts of the manufacturer's works concerned with the manufacture of the pipe ordered. The manufacturer should make available to the inspector, without charge, all reasonable facilities to satisfy the purchaser's representative that the pipe is being manufactured in accordance with these special requirements. The API Specification further states that all inspections should be made at the place of manufacture prior to shipment, unless otherwise specified on the purchase order, and shall be conducted so not to interfere unnecessarily with the operation of the works.

This last sentence is interpreted by some mills to mean that the manufacturer shall not be obligated to delay any of his operations because of absence of inspection. Other manufacturers interpret the entire paragraph on inspection to mean that following final inspection and acceptance by the purchaser, the manufacturer shall have no further responsibility or liability for any direct or consequential loss, damage or liability resulting from any defect in material or workmanship, or for any other cause except a pipe section having been shown at time of shipment to have been defective for the purpose for which it is customarily used.

The API Specification also states that material which shows injurious defects on mill inspection, or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected and the manufacturer so notified. The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser may make any investigation necessary to satisfy himself of compliance by the manufacturer and may reject any material that does not comply.

There is no question that the API Specification as now written represents the best thinking and combined judgment of the entire industry—both users and manufacturers. Nevertheless, the specification is still not beyond reproach when it fails to recognize the possibility of serious damage being inflicted on high-test line pipe in transit, or due to mishandling in storage, stockpiling or loading, or due to defective railroad equipment and inadequate dunnage protection. Experience in the past few years has shown that the high-test line pipe is sensitive to "notch" type stress raisers, which result in initiation of cracks.

Major precautions to be taken by the pipe mill's transportation department should be exerted towards minimizing occurrence of stress raisers (gouges and sharp dents) on pipe surface. Surface damages are caused by rough handling of previously "accepted" pipe. Other contributing factors to crack initiation are the suspected effects of "casual" car loading practices on the longitudinal stress along the "heat affected" zone of the longitudinal seam with resultant fatigue failure in service.

In any large scale, repetitive operation, adoption of an adequate inspection procedure to assure the best quality control of the product is imperative. This inspection starts with plate at the pipe mill, where the customer's chief inspector checks surface quality, trimming edge and physical and chemical tests on each heat of steel. During pipe manufacture he checks dimensional setups of pipe forming equipment. At welding stations he checks welding speeds, welders' generating voltages and currents, general weld quality and its dimensions. The customer's chief inspector periodically verifies conformity of materials used in fabrication with specific requirements of the purchase order. This phase of his work is initiated at the starting time of the manufacture by checking requirements of the order and of the API Specification with those issued by the fabricator.

From the foregoing, it is evident that the chief inspector occupies a very important place in the customer's organization. Technological ability, tact, impartiality and thoroughness are all essential qualities of a good inspector. To understand problems of fabrication, he must have a knowledge of materials, of manufacturing processes and tools. His acceptance or rejection of work must be based entirely on merit or lack thereof, and on established specifications. He must avoid arbitrary methods of inspection at all times.

Because the "dimensional" inspection of the pipe requires 100 per cent inspection and also because most mills insist that inspection be made at the rate of manufacture, the chief inspector should have two or three assisting inspectors per shift to do the routine type of "dimensional" inspection.

Assisting inspectors' duties consist of:

1. Internal inspection of every joint of pipe, positioned so that the longitudinal seam is in the lower half of the pipe. Inspection for seam quality and pipe surface is made by going through the pipe on a dolly with a powerful light.
2. External inspection of every joint of pipe, seam up, for seam quality and pipe surface. This is accomplished by walking the sides of the joint.
3. Inspection of both ends of a joint for bevel and land, using bevel gauge.
4. A check of exposed cross sections and the surface of the seam at each end for porosity, inclusions, cracks, lack of fusion, incomplete penetration, the root pass "push-through" and reinforcement of the weld, its height and uniformity of contour.
5. A check of the wall thickness at each end with a snap gauge.
6. A check of the pipe OD for a distance of 4 in. from each end as measured with a diameter tape.
7. Maintenance of a record of the number of joints inspected, the number accepted, the number rejected, with explanations of the reasons for rejection. ■

This article is adapted from a talk presented at the PCGA Transmission Conference, held May 27 in Salt Lake City.

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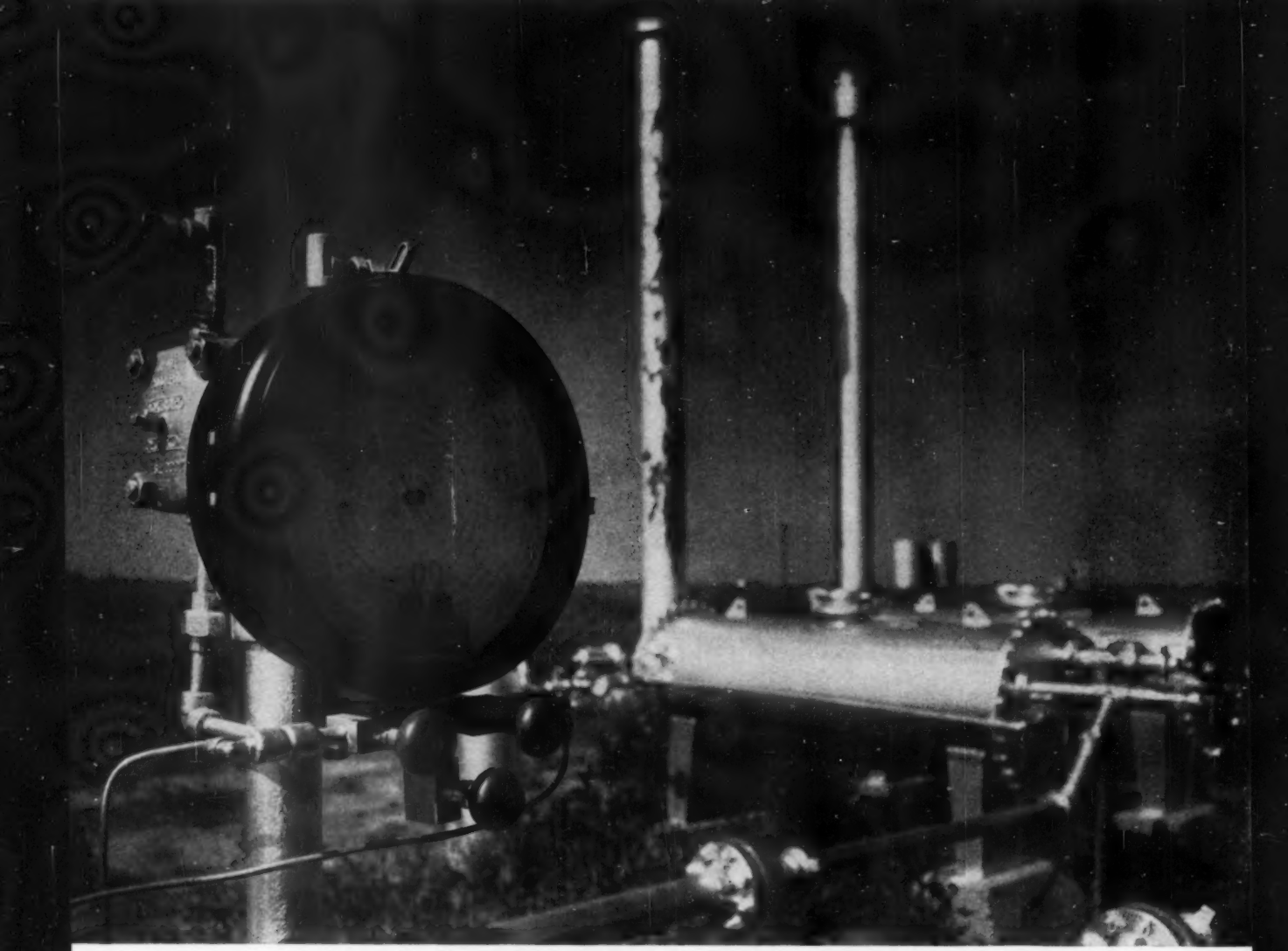


One of the 11 Foxboro T/37 Diaphragm Flow Meters, measuring wet gas to separators, at W. L. Pickens' North LaWard Field, Jackson County, Texas.

"Wet gas can't foul it . . . overrange can't hurt it . . . and it doesn't need maintenance"

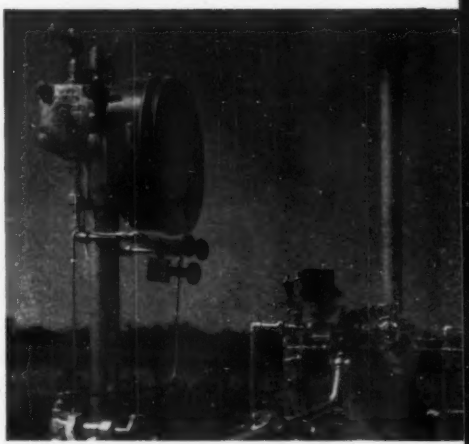
THE FOXBORO T/37 DIAPHRAGM FLOW METER

"Undoubtedly the most reliable flow meter we've ever used." That's the report on the 11 Foxboro Diaphragm Flow Meters at W. L. Pickens' North LaWard Field in Jackson County, Texas.

Walter B. Hollow, Drilling and Production Superintendent, states that even though these meters have been in service over a year, none have ever needed re-calibration.

"The Foxboro Diaphragm Meter also eliminates a problem we had of mercury being lost on sudden overranges caused by line surges," Mr. Hollow adds. "And of course, our weekly chore of draining mercury to remove water is a thing of the past."

Producers, pipeliners, plant men — they're all praising this outstanding Foxboro flow meter. Get the complete story on the T/37 in Bulletin 7-15. Or ask your nearby Foxboro Field Engineer. **The Foxboro Company, 347 Norfolk Street, Foxboro, Massachusetts.**



Specially-formed diaphragm discs and solid metal spacer rings insure the T/37 Diaphragm Meter from overrange damage. Spacer rings also protect diaphragm assembly from rupture or distortion by dirt particles—or hydrates formed in moisture of gas lines.

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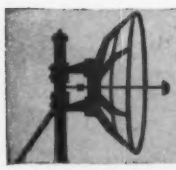
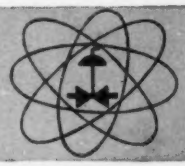
FIRST IN FLOW METERING



Communications and Automation



Edited by FRANK CHAPMAN

Keller reports to AGA

DOWN in New Orleans, in May, during the AGA's Combined Distribution-Transmission Conference, we were very interested in hearing Joe Keller's discussion of three interrelated microwave matters. Joe is, as you know, special representative of AGA's Communications and Tele-Control Committee in Washington. He provides a similar Washington service to API's NPRFCA Executive Committee and to The Central Committee on Communications Facilities. His firm is Dow, Lohnes and Albertson, of Washington, D. C.

The first matter discussed was the overall microwave proceeding: Docket No. 11866 — Above 890 Megacycles. The FCC issued a Report and Order on this proceeding last August. Users of private point-to-point microwave facilities heralded it as a landmark decision. However, certain common carriers petitioned for reconsideration.

"Consequent to the petitions for reconsideration," Keller said, "the commission stayed the effectiveness of this basic decision. As of this time (mid-May), therefore, nothing further has been done by way of implementing the basic decision." And ". . . it would appear that the hard-fought battle for private point-to-point licensing for all of private industry is far from over."

Joe Keller closely linked the use of microwave communications with the development of automation in the gas industry. He pointed out that: "The future of automation is, in my view, assured as one of the great areas of communications expansion in the immediate future."

Next he discussed Docket No. 13083—Interim Microwave specifications. This is a Rule Making docket in which FCC proposes to form interim technical microwave standards (power, band width, beam width, and frequency tolerance) that will be approved for private point-to-point microwave licensing. Since the Central Committee and NCUR felt that the standards were unrealistic in terms of presently licensed microwave equipment, ". . . both NCUR and the Central Committee have asked the commission to extend grandfather rights to equipment already in use and to modify slightly the specifications for new equipment."

Keller told the delegates that: "As of this time, the commission has not issued any orders on this matter. I suspect that as a practical matter the implementation of these standards will depend somewhat upon the commission's ultimate decision in the overall microwave proceeding."

Docket No. 12940—Interconnection. This matter involves the right of railroads to continue interconnecting their private microwave facilities with the exchange and toll facilities of the various telephone companies throughout the country. AT&T would have the railroads forfeit this privilege if any of them construct new microwave circuits or replaced an existing circuit with more than 50 per cent microwave equipment.

The Special Representative told us: "This same proceeding . . . also involved the termination rights of petroleum, natural gas and power industries. By termination rights, I mean the right to connect private communications facilities . . . with leased PBX switchboards of the telephone company for purposes of intra-company communication."

Keller's analysis of this situation was: "I do believe that from the testimony which our intervention produced from the American Telephone & Telegraph Co. and from my cross examination of the telephone company witnesses, together with the appearance of witnesses for the Central Committee and the National Committee for Utilities Radio, that the termination rights of these industries have been secured once again." The actual decision, however, will not be released until next fall.

Then, commenting on other communications matters before the Friday afternoon (May 13) Communications Session, under the gavel of Colorado Interstate's W. I. Blount, vice chairman of the Communications and Tele-Control Committee, Joe Keller expressed these views:

On Tertiary Frequencies — "I would like to say that it is my firm belief that within a relatively few years, use of the 15 kc offset frequencies will expand considerably and provide, in effect, an even further 'channel-splitting,' thereby alleviating still further the frequency congestion in this (150 mc) band."

On frequency threats—"We all know of the increasing demands being made by private industry, the common carriers, the Federal Government — particularly for space communications — upon the frequency spectrum. . . . I would admonish all here to ever be watchful for the demands made upon the frequency spectrum by the Office of Civil Defense Mobilization. . . . It is oftentimes very difficult to question the needs of the OCDM for additional frequencies because of the cloak of security under which these requests are made." And . . . "both the common carriers and the Federal Government can be looked to for increased demands

Continued on page 134

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Your TUBE TURNS' Distributor has a complete line of light weight fittings

Typical of the results of changeover to light weight distribution lines are these, reported by a large gas utility:

Pipe costs less. For example, 8" x .188" wall pipe, cost is about $10 less than 6" standard weight pipe.

Installation is faster because of easier handling and simplified welding procedures.

Handling costs less. The 8" light weight pipe is 10% lighter than the 6" standard weight.

Flow efficiency is greater. For these sizes, flow area of the light-wall pipe is 85% greater.

To enable you to take full advantage of the economies of light weight piping, Tube Turns offers a complete line of forged steel light weight fittings and light weight Taper Face Flanges. They meet all code requirements. Available promptly from your nearby Tube Turns Distributor. For complete details, mail coupon for Bulletin TT 942.

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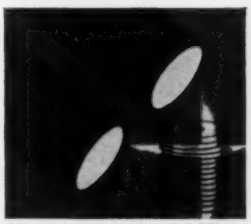

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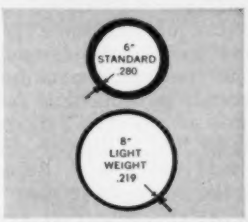

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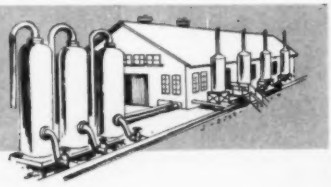


School covers gas transmission problems

A BALANCED program covering important problems in natural gas transmission characterized the 15th annual Short Course in Gas Technology. Sponsored jointly by SGA and Texas A&I, the course was held on the latter's Kingsville campus, June 1-3.

Gulf Interstate's Clarence Taylor surveyed recent advances in combustion turbine design, and gave data on the ultra-high-speed, compact units now being service tested in pipeline compressor drives. A feature of the new units is the ease with which maintenance replacements can be made, or an entire new turbine supplant one removed for servicing.

Drs. D. A. Flanagan and Paul B. Crawford, Texas Petroleum Research Committee, discussed underground liquid methane storage. Their presentation was limited to the mined type of storage reservoir, on the premise that suitable salt dome structures are rarely present in the areas where storage is desired. Their data showed that on the average, underground storage costs less than half that of aboveground storage, while holding evaporation losses to less than 0.0025 per cent per year in a well-constructed reservoir.

Walter A. Gunkel, Southwest Research Institute, summarized two years' experimentation in the supersonic testing of pipe for extent and location of defects. Pointing out that although less than 0.0001 per cent of all pipe turned out proved to contain defects, service now demanded of pipe makes it necessary to ascertain its soundness, preferably through some method which will supplement or supplant human judgment with test data. Oriented supersonic wave generating units, so positioned as to provide various traverses of the pipe material and reflection of the waves—at 30,000 cycles per second—from defects on the inner surface of the pipe, accurately locate nonconformities. It remains only to perfect a device to evaluate the findings in terms of pipeline service, and thus to eliminate the element of human decision.

Louis E. Connealy, Texas Eastern Transmission, outlined his company's experience in the control of gas hydrates through the injection of methanol. Successful control requires a study of the system for injection points; pumps for proportioned injections of the inhibitors; supervision of supply sources for them; and provisions for exchanging or shifting pumps to protect exposed sections of line in emergencies.

Although his company uses methanol, and would find a change to any other control system expensive, Connealy recommends a study of the comparative costs of heat, glycol injection, and methanol before installing hydrate control on a new system.

F. S. Maslyk, Stone & Webster Engineering, discussed the process and economics of storing propane—a step of increasing importance with the greatly augmented take of butanes by the petro-chemical industry and the consequent shift to propane for bottled domestic or industrial fuel.

W. F. Barker, Tennessee Gas Pipeline Co., and W. M. Deaton, U. S. Bureau of Mines, led a two-hour open forum on dehydration of natural gas. The various systems for removing water vapors from the gas stream were evaluated and comparative costs cited. Selection of the method was shown to be a matter of economics, flow temperatures, and condition of the gas as received.

Leo B. Croley, Phillips Petroleum, gave test data on a new high-density polyethylene pipe being fabricated from a raw material developed and produced by his company. The new pipe is used in the 100-psig pressure range, and shows greatly increased hoop strength as the working pressure is lowered. It may be bent to relatively close arcs when heated, and fitted with preformed ells for even closer limits. Chemically inert, the pipe finds application in pharmaceuticals, food products, water lines, and natural gas gathering systems.

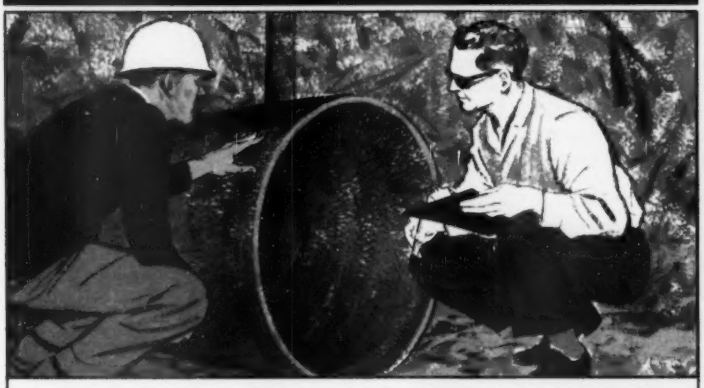
Following the talk, a portable field jointer was demonstrated. This device, with self-contained electrical power plant, carries clamps for holding adjacent pipe ends, a heating plate for bringing the end temperatures up to 380-400 deg F, and means for pressing the pipe ends together after the plate is withdrawn. The joint cools in 30 seconds, and is stronger than the run of pipe.

Paul W. Nelson, Northern Natural, in the absence of the author, K. L. Wetterberg, read a paper on the determination of pipeline efficiencies. Northern uses ammonia to measure pipe flow rate against orifice plate calculations. The NH_3 is injected through a probe at 200 psig above the line value, and is detected at the next block gate site. Such tests average 10- to 15-mile spacing. Presence of the ammonia is detected by the reaction of a small stream of gas flowing through a phenolphthalein solution in a test tube. Results obtained by this method almost invariably showed a Q less than that from orifice meter calculation. He also discussed the use of radioactive argon. Charts and tabulations showed the close correlation between results obtained when using the two gases.

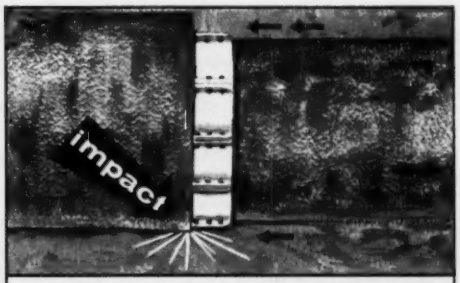
L. O. Harvey, Jr., Data Processing division of IBM, outlined automation in tomorrow's pipelines. He traced the development of computers for pipeline design and flow problems. And, he forecast the time—in the near future—when a data processing unit would take over determination of pipeline system conditions, compute the necessary station changes, and automatically change the functioning of the line equipment to attain the desired throughput.

NEWS FROM DOWN THE LINE!

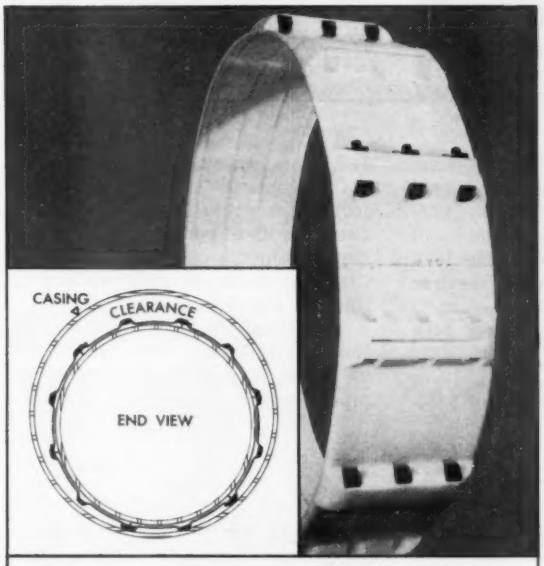
WmSON BIG-INCH M-2 THINSULATORS® MEET RUGGED TEST IN NEW JERSEY TURNPIKE CROSSING



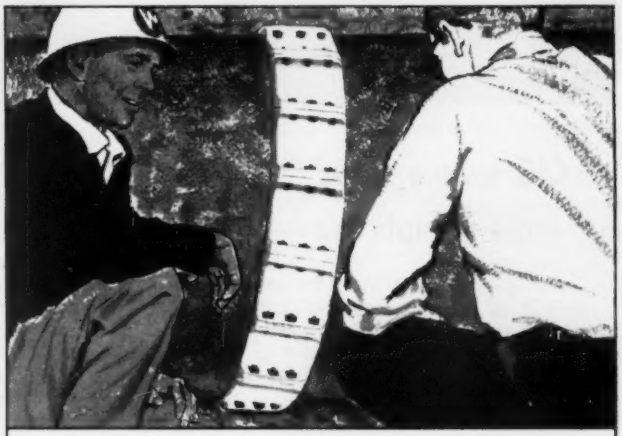
❶ "We'll pull the 36" drag section through this 275' casing. The casing has a slight dog-leg in the center which will make the pull a really tough test of the THINsulators."



❷ "M-2 THINsulators are high-density polyethylene products, resistant to fracture under tremendous impact. Most other plastic insulators are fiberglas reinforced polyesters that don't have the impact resistance, so breakage rates are high."



❸ "The high density polyethylene gives the M-2 such strength it can be made more compact than other insulators, allowing more clearance. It's flexible, so it conforms to the pipe for uniform coating loading . . . and the low coefficient of friction makes it slide like it's greased."



❹ "The tremendous force of the pull caused the lead THINsulator to absorb most of the shock. It twisted slightly but remained intact. All hands agree this is the best plastic casing insulation they have used."

❺ "Consider the economy of M-2 THINsulators. They cost no more than other plastic insulators, and breakage is **practically unknown.** Bend 'em, beat 'em, you can't break 'em."

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69,000 trillion Btu needed by 1975

By 1975 an estimated population of 228 million in the U. S. will require 69,000 trillion Btu. And, natural gas is expected to account for 31 per cent of this energy demand.

Henry Hart of Standard Oil Co. (Ind.) said petroleum would account for 40 per cent; coal, 19 per cent, and atomic energy, 5 per cent.

"Natural gas is seen to be the only one of the major fuels expected to increase its market penetration by 1975," he said. Hart was addressing a meeting of 350 scientists, engineers and economists of Standard of Indiana and its affiliates. He is section director for marketing economics.

Atomic energy probably will be confined to only a few industry applications, gaining its first commercial foothold by 1975.

A study showed total demand for natural gas is expected to increase 4 per cent per year through 1975.

There will be enough gas available in 1975 to meet demands, and we'll still have a reserve for 18½ years based on present conditions, Hart forecast. However, with tight FPC price regulation and increasing imports of cheaper crude, supply of natural gas would be seriously reduced.

Demand still could be met, Hart said, but reserves would drop and some gas probably would have to be imported.

These portable, packaged meter stations from Daniel Orifice Fitting Co. are bound for wellhead sites in Oklahoma's Laverne field. More than 50 of the units were bought by Michigan Wisconsin Pipe Line Co., which is tying in additional gas wells and taking the gas into its integrated gathering system. Then, the gas is transported 40 miles to Michigan's mainline. The units are skid-mounted and fitted with single or dual meter tubes as required. They are housed in prefabricated metal buildings assembled at the Daniel plant in Houston.

CIG testing Texas' gross receipts tax

A test case will decide whether field sales of pipelines are subject to Texas' gross receipts enforcement tax. Colorado Interstate Gas Co. filed suit in the 126th District Court.

In December, 1959, Texas attorney general Wilson ruled that field sales are subject to the tax. CIG attorney R. Dean Moorhead said this move would convert the levy from a minor to a major revenue raiser if allowed to stand.

Interstate has paid—under protest—about $160,000 since last year's ruling. Included: $93,570 in back taxes for 1952-1959 and $49,707 for additional 1959 taxes.

CIG contends the only sales subject to the gross receipt tax of one quarter of 1 per cent are those made from the company's mainline—not those made from gathering lines in the field.

If Wilson's interpretation stands, the tax would apply to such sales as those made by CIG to other pipelines for resale.

Three companies to share new storage

Laclede Gas Co., Mississippi River Fuel Corp., and Illinois Power Co. are going to share in a new storage area being developed near St. Joseph, Ill.

The three will share the gas storage available and operational and development costs. It breaks down like this: 64 per cent for Laclede, 25 per cent for Mississippi, and 11 per cent for Illinois.

Laclede president H. R. Derrick hopes the new gas source will be operating by the end of the year.

Capacity of the area, which will cost about $1.5 million to develop, hasn't been determined. "We think it will at least double the effective daily deliverability of gas from that source on a peak day basis," Derrick said.

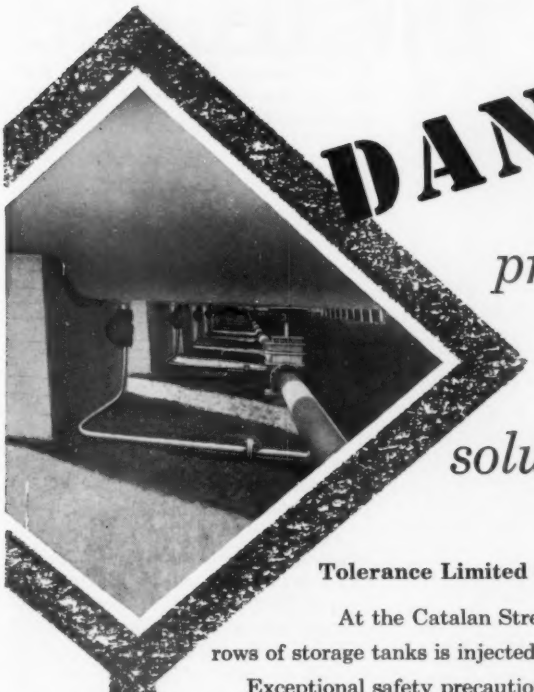
Laclede will be able to "take care of all" the 23,200 applicants for conversion to gas heat that were on file March 31. It is aiming at broadening its heating customers well beyond the 59 per cent saturation now in its St. Louis marketing area. Based on an average annual sale of $100 to each customer, the addition of just the customers seeking gas service now would add $2.3 million to future yearly revenues.

West Virginia reserves to Amere Gas Utilities

Amere Gas Utilities Co. is going to buy 40 billion cu ft of West Virginia reserves from United Producing Co. The recently signed contract covers gas reserves developed by United on 16,000 acres.

Purchase price is 27½ cents per Mcf at the wellhead. Also involved is payment of 2½ cents per thousand to United to cover gathering and delivering costs.

Amere expects to spent more than $1 million on pipeline and compression facilities. United's ultimate investment in wells and gathering facilities will probably top $2 million.



DANGER!

problem: FIELD WELDING NOT PERMITTED!

solution: SHOP FABRICATION BY MIDWEST!

Tolerance Limited to 1/16" on Inlets to 500-Ft. Header.

At the Catalan Street Station of Laclede Gas Company, St. Louis, propane from rows of storage tanks is injected into the natural gas supplied to Laclede customers. Exceptional safety precautions precluded field fabrication and welding on piping to connect natural gas lines and the propane tanks.

Instead, Midwest shop-fabricated the propane headers in lengths up to 70 feet, complete with nozzles and tank outlet piping for flanged connection to each tank. These connecting lines had to be - and were - accurate in alignment within a tolerance of 1/16".

Midwest's four fabrication plants, strategically located, are within easy reach of your next job. Contact Midwest for piping fabrication.

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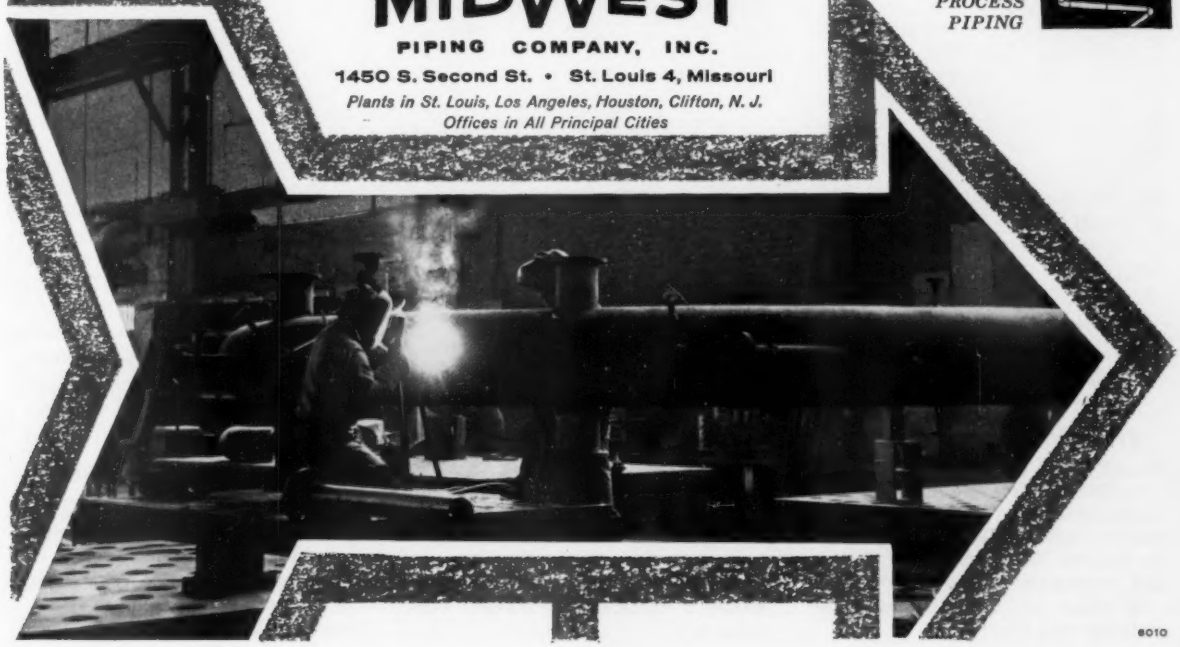

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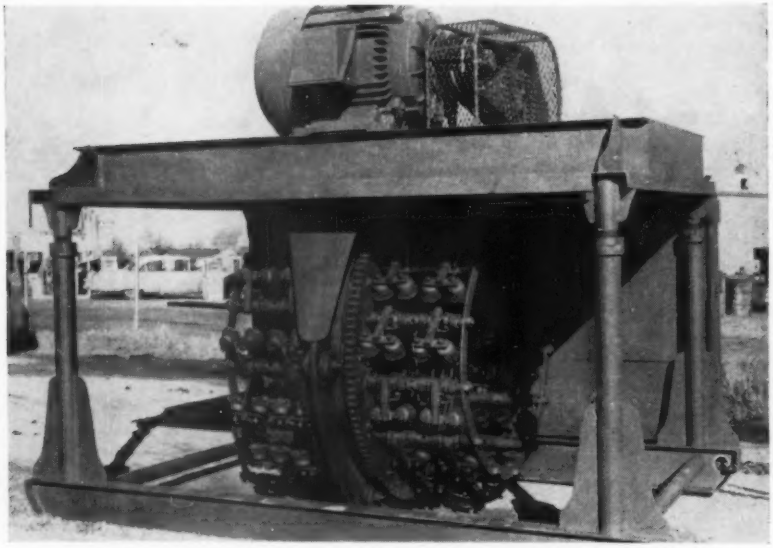

What is believed to be the largest mechanical pipe-cleaning machine was built recently by Remco Manufacturing Co. Capable of cleaning 24- through 42-in. pipe, the complete machine weighs 20,000 lb.

FPC must reconsider Panhandle-Michigan case

FPC has to reconsider its 1958 order allowing Panhandle Eastern Pipe Line Co. to cut off gas sales to Michigan Consolidated Gas Co.

The U. S. Court of Appeals ruling marks the 15th time the long fight has been in court.

Panhandle has been supplying 127 MMcfd since 1935 to the American Natural Gas subsidiary. In turn, Michigan Consolidated resells the gas in Detroit and nearby areas. For several years, Panhandle tried to get the cut-off order from FPC. It came finally in 1958.

The three-judge court unanimously held that FPC based its decision on a "fatally defective" comparison between Panhandle's needs and those of Michigan Consolidated. The court also found FPC had not made a strong enough case for an argument that the public would benefit by a severing of relations between the two companies.

The opinion hinted that the judges favor a compromise plan suggested by Michigan. "The settlement proposal promises to fulfill the commission's announced objective of distributing gas to the consuming public on the basis of need, even more fully than total abandonment."

Under the court order, FPC must consider Michigan's plan when it restudies the case. The plan would allow Panhandle to use all the 127 MMcf in the winter months for heating needs of its domestic and industrial customers. Then, in the summer, Panhandle would sell the gas to Michigan. Sale would be at a stepped-up volume to make the annual amount supplied come out the same as it does currently. Michigan would store the gas for winter use.

Panhandle's refusal to accept the settlement should not have kept FPC from considering its merits, the court ruled.

El Paso enters petrochemical field

El Paso Natural Gas Co. and Rexall Drug & Chemical Co. have joined to produce and market petrochemicals. The joint venture includes plants at Odessa, Texas, for production of olefins, polyolefins, and chemicals.

El Paso will furnish raw materials for the plants.

NI-Gas works on new line

Work is under way on Northern Illinois Gas Co.'s 75-mile line between its Troy Grove underground storage reservoir and LaGrange.

Scheduled for autumn completion, the line will transport gas from the reservoir to meet next winter's demands of NI-Gas customers.

Glick field sales ok at 17 cents per Mcf

Five producers can sell Glick field gas to Northern Natural Gas Co. (Dockets G-17973 et al).

In February, FPC examiner Weston authorized the sales, conditioned on a 16-cent per Mcf rate. The producers wanted 20 cents. But the commission compromised on 17 cents per thousand.

The commission turned down the examiner's provision calling for the 20-cent rate one day after service began. "If the line established by the initial price is abandoned within a day, the market will establish a new high price at the effective contract price of 20 cents," the commission said. FPC experience shows that while the new high price is conditional, and subject to refund, "it tends to set a new price plateau."

Permitting a new high rate inevitably results in the new price becoming the prevailing price. Also, "since such a price will be subject to refund, it will only increase the uncertainty of prices in the gas industry. . . ."

Also, FPC said that 20 cents was out of line with the 17-cent price prevailing in nearby Laverne field. Quality of gas in relation to price was ruled upon too. Rather than trying to adjust the price of pipeline quality gas in terms of estimated values in the gas processing industry, FPC eliminated an upward Btu adjustment.

Northern's construction includes 21 miles of 16-in. line from its Mullinville station to Glick field and about 26.5 miles of small pipe. A new dehydration and hydrocarbon extraction plant will have a capacity of 50 MMcfd. Cost: $1.7 million.

Arkansas line okayed

An Arkansas Louisiana Gas Co. subsidiary has won approval of its plan to build a 130-mile gas line from Perla to Helena, Ark. Arkansas Industrial Pipeline Corp. will operate the 18-in. line.

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Heaviest pig diverters shipped to California

What are believed to be the heaviest pig diverter lateral fittings have been shipped by Tube Turns division.

The two 7-ton laterals will be installed on the 116-mile run of 34-in. pipe under construction in California's Mojave desert. This Pacific Lighting Gas Supply Co. line runs from Needles on the Arizona border to Newberry.

The fittings measure 10 ft from end to end. They are made of a special low-alloy, high-strength steel with 1.5-in. thick walls. They can withstand service pressures of 1050 psi at 100 deg F. Each is reinforced by a welded three-way collar of horseshoe-shaped steel forms —weighing more than 2 tons themselves.

More than 600 manhours and 500 lb of electrode were used in welding each of the special fittings. This was followed by an additional 14 hours to radiograph each finished fitting. At one point where weld metal was deposited to a depth of 6 in. in the "V" of the branch connection, an exposure time of three hours was required for the radiograph.

One of the fittings will be installed at the Newberry meter station, the other at the Minneola storage field. Two other pig diverter laterals of the same size will be shipped later to the Needles end of the new pipeline.

Trunkline opens pipeline extension

Gas from Texas, Louisiana, and the Gulf of Mexico is flowing into Michigan through Trunkline Gas Co.'s new pipeline extension.

The 100-MMcfd flow to Consumers Power Co., Jackson, benefits some 300 Michigan communities. About half of the gas comes from offshore wells. The offshore rate will increase as deliveries to Consumers are boosted. An ultimate delivery volume of 200 MMcfd is planned.

Trunkline's 204-mile mainline extension marks its entry into market diversification. Heretofore, the Panhandle Eastern Pipe Line Co. subsidiary has supplied its parent with gas.

New company to move big Canadian reserves

A 250-mile pipeline linking huge new gas reserves of northern British Columbia to existing transmission facilities is planned.

Frank M. McMahon, president of Westcoast Transmission Co. Ltd., said the newly formed Gas Trunk Line of British Columbia Ltd. will build the new line after it gets a permit from the B. C. Department of Commercial Transport.

The 30-in. line—running from Fort Nelson to Taylor—will include a gathering system and plant facilities.

Cost of the first step, which includes drilling of new wells, will exceed $100 million.

McMahon said principal operating companies in the development of the province's oil and gas industry are participating in the project.

System capacity is an estimated 650 MMcfd. This, added to Westcoast's 650 MMcfd, means the province's total transmission potential will exceed 1 billion cu ft a day.

Trans-Canada boosts supply to Winnipeg

Under terms of a new contract, Trans-Canada Pipe Lines Ltd. is delivering 45 per cent more gas to Greater Winnipeg Gas Co.

The distribution company will buy about 92 billion cu ft of gas over the next 16 years, in addition to gas already under contract. Greater Winnipeg reached its previously anticipated fifth year of development in four years, according to Arthur R. Elliott, vice president and general manager.

Replacement approved

Ohio Fuel Gas Co. got an okay from FPC to install some 20 miles of replacement line. Diameters range from 4.5 to 24-in. The $1.2 million job will replace portions of OFG's system in eight Ohio counties.

Also approved was a new distribution system and gas service in North Robinson. Peak day demands are estimated at about 160 Mcf in the third year.

More offshore gas for TGT

Tennessee Gas Transmission Co. is building new facilities to take gas from offshore Louisiana (Docket CP60-64). The $1 million job consists of 11.6 miles of 12¾-in. line and appurtenant equipment. The gas is in TGT's own production acreage in the East Cameron area. Conservative estimates show about 102.9 billion cu ft of proven, developed gas reserves.

Northern studies growth potential

Northern Natural Gas Co. is studying the Omaha-Council Bluffs metropolitan area to learn more about its growth potentials.

This is believed to be the first time the metropolitan area has been treated as a single unit in such a study. Northern is making the survey, assisted by Industrial Planning Associates, a California research firm.

Houston Corp plans 400 MMcfd boost

The Houston Corp. plans to increase its pipeline capacity to 400 MMcfd late this year or early in 1961. The increase will be accomplished solely by added compressor station facilities.

President F. E. Stanley also announced tentative plans for a hydrocarbon extraction plant. To be owned jointly with Sun Oil Co., the plant will be located on Houston's 24-in. mainline near Brooker, Fla. It will produce LPG and natural gasoline.

Manufacturers builds

Manufacturers Light & Heat Co., Pittsburgh, is spending $7.7 million on recently approved construction (Docket CP60-17). Involved is 103.4 miles of 20-in. line in six Pennsylvania counties. At the same time, Manufacturers is abandoning 133 miles of 6-in. and 131 miles of 8-in. Also, 700-hp and 1600-hp compressor stations at Greencastle and State Line.

"When we invited our people to join, our participation jumped 20%!"

"Early last month I checked with our Payroll Department. I found that less than 28% of our employees were enrolled in the Payroll Savings Plan. So I contacted our State Savings Bond Director and asked for his help and advice.

"He worked out an effective plan by which every person in our company was *invited* personally to join the Plan. You know, sometimes you hesitate to do a thing like this. Employees may think you are trying to use a little pressure. But the way we did it, there wasn't any pressure at all. We just explained the advantage of this systematic way of investing, and showed how convenient it is. Then we invited them to join with the millions of other Americans who are building personal security—and strengthening our country's peace power—through Savings Bonds. As a result we have better than 45% of our staff enrolled, and our participation is improving every payday."

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Boosts withdrawals

Natural Gas Storage Co., Chicago, is going to increase maximum day withdrawals from Herscher and Cooks Mills storage fields by 75 MMcf. Total withdrawal will be 650 MMcfd.

FPC approved Storage Co.'s plan (CP60-28) to drill two injection-withdrawal wells, construct a 0.56-mile, 36-in. crossing of the Illinois river, and 0.3 miles of 10-in. gathering lines. An estimated $2 million will be spent.

Welding book published

The Third Section of the 4th edition of the "Welding Handbook" has been published. The 512-page volume contains 335 illustrations, 78 tables, and a comprehensive index. Special welding and metal joining processes are covered, as well as arc cutting processes.

For additional information on the handbook, write to American Welding Society, 33 W. 39th St., New York 18.

Mississippi crossing ok

Columbia Gulf Transmission Co., Houston, has FPC okay on its dual 24-in. underwater crossing of the Mississippi (CP60-25). The $3.5 million project consists of 2.36 miles of 24-in. and 4 miles of 30-in. pipe.

Compressors bought

Nine of Clark Bros. Co.'s Model TLA turbocharged gas engine-driven compressors will be installed on Midwestern Gas Transmission Co.'s system. Total bhp is 16,200.

Three units each will go on the Northern Minnesota and Staples, Minn., stations of the 24-in. line running from Canada, southeast across Minnesota and down into central Wisconsin. Three others are slated for installation in the Petersburg (Ind.) station of Midwestern's existing line.

Chemetron buys Glasgow firm

Chemetron Corp. is buying Clyde Tube Forgings Ltd., Glasgow. Clyde is a leading British maker of welding fittings for industrial pipeline and pipeline transportation systems.

The Tube Turns division of Chemetron will coordinate Clyde's operations with its own.

regulatory • *Cont'd.*

from page 11

trary view. They contended that there is no deferred tax liability and that the result flowing from the use of liberalized depreciation is actually a tax saving to the taxpayer.

The majority stated that the record in this proceeding is clear that California public utilities, for the foreseeable future, will continue to construct new plant to an extent which will be sufficient to more than overcome retirements to such plant. In such circumstances, the theory of normalization, based upon the concept of a deferred tax liability, would not have an opportunity to operate.

The majority found that there is created no income tax deferral and no deferred tax liability; and that the operation of Section 167 provides a vehicle for the taxpayer to reduce his taxes just as though the tax rate had been reduced. So far as tax liability may be concerned, the end result would be the same in each case. Should this commission adopt the so-called normalization theory, it would be required to close its eyes to the obvious facts of the future which can reasonably be expected to result from California's tremendous economic growth. There is no duty incumbent upon this commission, said three commissioners, to adopt a theory which is at war with the facts of experience and the reasonable expectations for the future.

The majority looked at two old Supreme Court cases. Then they said that it would be a negation of the rule established by the Supreme Court in those two cases to hold that the ratepayers of a public utility could be required to bear the burden of a charge to the operating expense of a public utility which represented more income taxes than the taxing authority lawfully assessed and were actually paid by the utility.

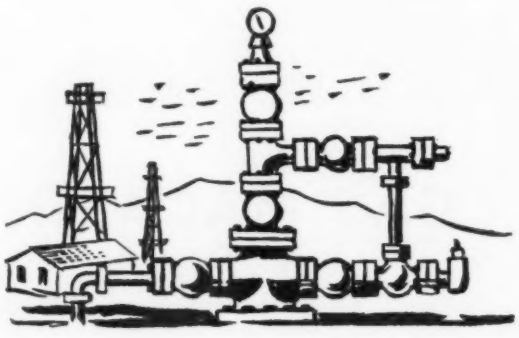
The philosophy of the majority continues: A regulated company enjoys a distinct protection which the unregulated company does not; that is, the regulated company may turn to public authority for the purpose of securing an increase in the price of its services or product, while the unregulated company must withstand the rigors of the law of competition. In many instances the public utility enjoys a monopoly, and the rates which public authority permits it to enjoy must be paid by the consumer without his being aided in any way by the law of competition.

The majority concluded that as a general proposition, it is a matter to be determined in the first instance by the management of a public utility as to whether liberalized depreciation will be taken or whether straight-line depreciation will be used.

• Illinois supreme court's views

The Illinois supreme court in the current City of Alton water rate case made a more reasonable appraisal of the problem in upholding the Illinois Commerce Commission's normalization of income taxes. The court stated:

"A war, a general depression or a decline in the local market might curtail a utility's capital expenditures, and prevent further tax deferrals. As a result, taxes might increase just at the time when economic circumstances would make



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the added expense most burdensome. It is also possible that Section 167 will be repealed, thus ending further tax deferrals.

"If we could see clearly into the future and say with certainty that continuing expansion was certain, and countervailing considerations were nonexistent, we would hold that the commission may not permit current charges for a liability that will never arise. Predictions of future developments, however, are unsure estimates at best. The problem is a new one; that factual and policy considerations that bear upon its solution have not as yet been fully developed. Even the future of accelerated depreciation in the Federal tax structure is not entirely settled. If for any reason continued investment in utility plant at current levels should cease, or accelerated depreciation be denied, the financial stability of utilities might be jeopardized if some provision had not been made for the increased taxes that would result. Rate regulation is a continuing process; greater experience may bring greater wisdom in dealing with these problems. At this time, we think it permissible for the commission to safeguard the financial integrity of utilities by recognizing as present expenses those tax liabilities which are deferred by use of accelerated depreciation for Federal tax purposes."

Air conditioning in Houston

On its way up the side of the new 32-story First City National Bank building in Houston is the 75,000-lb gas-operated boiler shown at left. To meet requirements of compactness and noise-free operation, steam turbines will drive compressors of the 3600 tons of cooling equipment. Steam from the gas-operated boilers provide heat as well as power for the turbines. A huge crane with a 28-ft beam was fabricated on the roof to hoist the three boilers to the top. Then they were lowered through a giant hole to the permanent location on the 31st floor of the marble and glass office tower.

Washington • *Cont'd.*

from page 15

tionship between governmental control of the fuels industries and full employment." This amounts to a study of what the government can or should be doing to make certain that all segments of the fuels industries are protected from too much competition.

In other words, is one segment (gas and oil) hurting the other (coal)?

This will be a warmup to an eventual full-blown congressional fuels study. But it will be worth watching on the part of the gas industry.

GAS industry antagonists are laying the groundwork now for an all-out assault next year in Congress on successive temporary gas rate boosts.

Reps. Larry Brock (D., Neb.) and John Dingell (D., Mich.), among others, have been continually criticizing the gas industry for putting into effect, and the Federal Power Commission for not prohibiting them, a second or third temporary rate increase before the first one is formally acted on by the commission.

Consuming communities have been "excessively taxed" with increased gas rates without the right to contest, they claim. Natural gas "has been definitely proved (to be) a cheap commodity—it costs little to produce—it is the result of a natural element escaping from a hole in the ground which originally was expected to produce oil," Rep. Brock charges.

Several congressmen introduced bills this year to prohibit the FPC from permitting a temporary rate increase to go into effect while there is an earlier rate increase proposal pending.

None of the sponsors note that if the present unworkable system of federal control of the industry were untangled, so the FPC could quickly impose the limited regulation necessary, such successive increase would never come into play.

PROSPECTS of huge importations of Canadian gas into this country in the next few years is going to further inflame the market battle now underway between natural gas and coal.

Coal spokesmen have been balked in their efforts to block importation as direct intervenors in various cases in which importation of Canadian gas is involved. But they haven't given up.

With the failure to close the door to imports by administrative pleas pretty well set, coal interests now are going to Congress in the hope they can get quick help there next year.

The big push will be to try to get through Congress legislation to either limit gas imports, impose

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- Retractable brush unit minimizes pipe entry damage. Pressure of high speed circular wire brush indicated on operator's console — for easy adjustment during operation.
- Large capacity continuous operation vacuum pickup system removes refuse during cleaning and coating operations.
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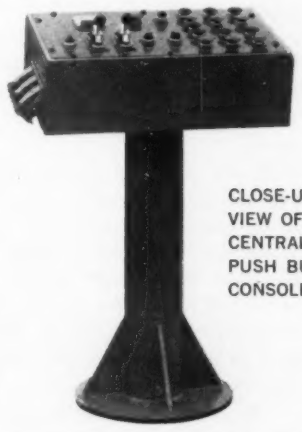
- Operator controls machine operation from centralized push button console . . . he does not have to ride boom car.



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CROSE announces the newest development in pipeline construction equipment. The Crose internal cleaning and coating machine is the fastest, most efficient machine on the market, requires only two basic cleaning heads for all pipe sizes from 16" through 36", and is available on a for sale or lease basis. This electric-driven machine comes complete with pipe handling and spinning rack. Requires a minimum crew of four men . . . can be moved easily from one job site to another, or can be permanently installed.

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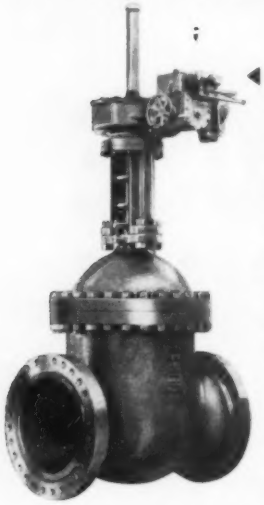

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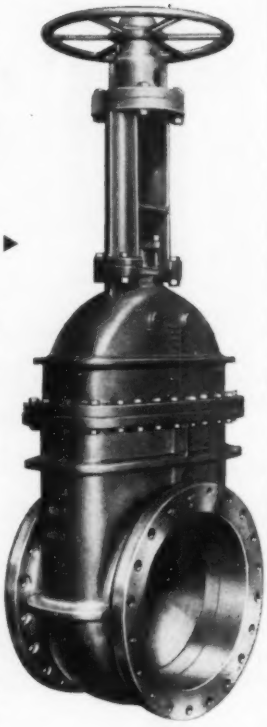

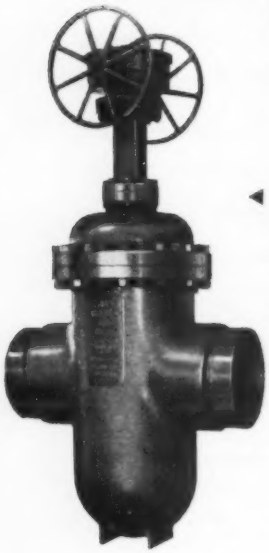

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a tariff on them, or at least prohibit either through U. S. law or by restrictions in Canadian export permits the sale of Canadian gas for industrial uses.

Importation of Canadian gas "would not be as objectionable" if industrial consumers had to pay their full share of the cost, Tom Picket, vice president of the National Coal Association, says.

The coal industry claims that if off-peak sales of Canadian gas to industries on an interruptible basis were forbidden, coal would have less objection to the importation. He admits that a prohibition on industrial sales of this type would "limit" industrial use of Canadian gas, which would then reduce the competition for fueling these users.

Meanwhile, an FPC hearing examiner has approved with some reservations the largest single Canadian import project. Involved is the proposal of El Paso, Montana Power, and Pacific Gas Transmission to import some 585 MMcf a day from Alberta & Southern Gas Co., Ltd. The project has been approved for export by the Canadians.

Examiner Robert M. Weston, in a decision which was subject to full FPC review, conditioned his approval on an agreement by U. S. and Canadian companies keeping the FPC informed of prices in the project. This will lay the foundation for a later agreement between the two countries on the prices to be charged for the gas at the border. Canadian gas is now not subject to price regulation. He also put off until later a rate of return to be allowed the three firms involved.

After several false starts, the Canadian government now is rushing to spur development of its huge untapped natural gas reserves.

Recent changes in oil and gas regulations were adopted in hopes of opening "wide new areas to development." At the same time, however, the changes restrict ownership of leases in an attempt to "guarantee Canadians an opportunity to participate in the financing and ownership."

The new regulations apply to submerged lands, including the

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continental shelf, as well as the Northwest territories and the Yukon.

Under the revisions, leases will be granted only when a Canadian citizen will be the "beneficial owner of the interest" and all companies to be granted a lease must be incorporated in Canada and Canadians must own at least half of the shares.

The life of exploration permits has been extended from nine to 12 years. ■

Gassing Game • *Cont'd.*

from page 19

Later statewide laws came out prohibiting the flaring of gas and requiring that it be used for some useful purpose such as recycling or lifting oil, or that it be closed in. In those days oilmen would have actually given anyone all the gas they had just to get the liquids or even to get the wells off their hands.

Even then many far seeing oilmen knew they were temporarily saddled with a problem that would eventually turn into a great advantage. But for the time they were finding gas without oil and often abandoning the wells as dry holes if they could get away with it.

Then came the great change that started toward the end of the war. The long gas lines started sprouting out from every corner of the southwest. Apparently, they came just in time to save many distributing companies and provide a source of gas to create many new markets for others. It was sometime in the 50's when oilmen started to actually look for natural gas. Before that they found it accidentally in their search for oil.

Today in Texas the average price of natural gas is about 13 cents. Some of it brings twice that, depending on the size of the reserve, the depth of the wells, and the quality of the gas. More than 550,000 barrels of gas liquids are produced daily in Texas alone.

And progress has been more pronounced than you might have thought.

There are no more oil editors running gas companies. ■

communications • *Cont'd.*

from page 117

on the spectrum for the space and satellite use."

On the new FCC commissioners —"Judging from the background of the new chairman and the decisions of the present commissioners, I would venture to say that for the first time in Federal Communications history the common carriers have no strong partisans sitting on the commission. I do hope that future decisions will bear this thought out."

By way of conclusion: "If you have received the impression from my remarks that our industries must be ever vigilant about their rights to enjoy and share in the frequency spectrum, you will have a fair estimate of the import of what I have said. . . . Events are moving with ever-increasing pace so that what is past is merely prologue to the activities in which we must engage to maintain our rights to utilize portions of the frequency spectrum for our industries." ■

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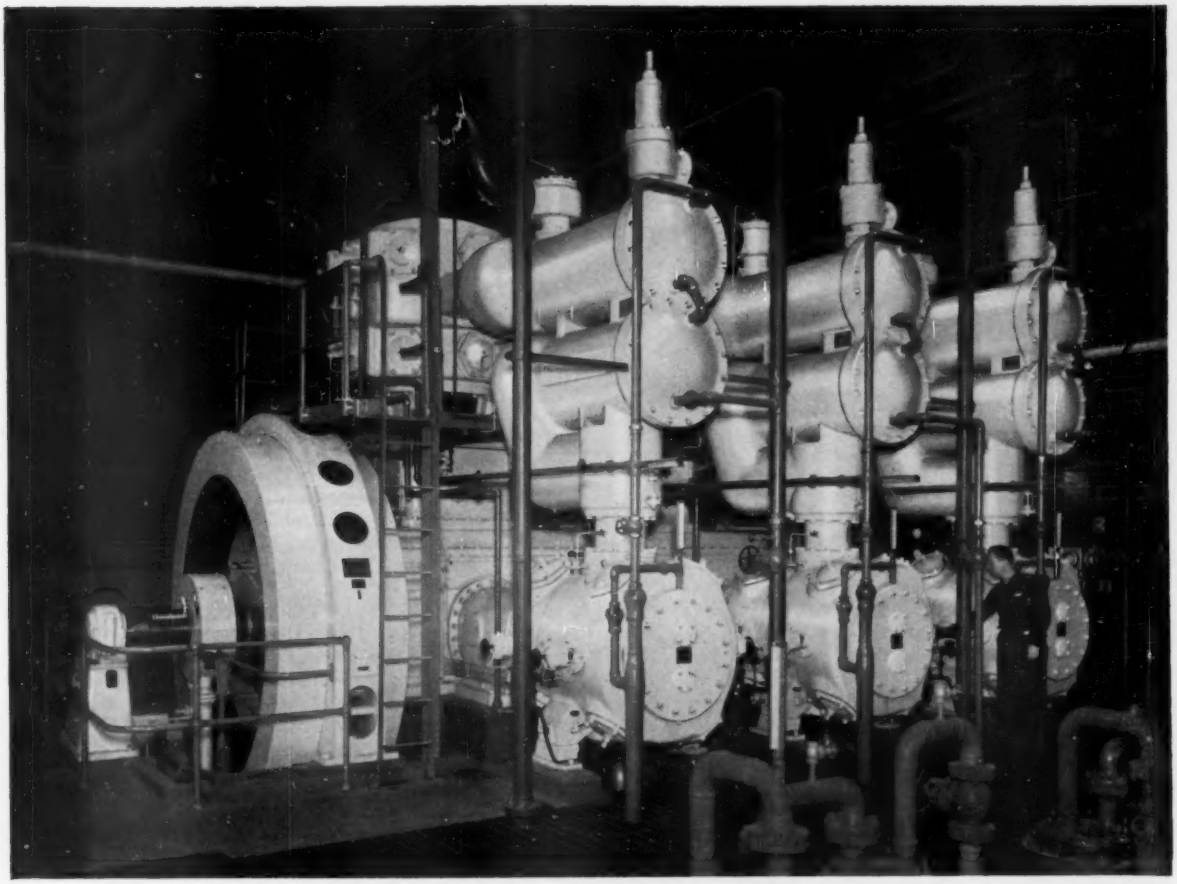

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24,000,000-cfd gas compressor uses minimum floor space

To assure all gas customers of an ample supply regardless of fluctuations in the demand, Philadelphia Electric Company requires a lot of compressor capacity. Installed at the Tilghman Street gas plant in Chester, Pa., the huge Ingersoll-Rand VHE compressor shown above can handle up to a million cubic feet per hour at 125 psig.

Driven by a 3000-hp synchronous motor, this two-stage unit with vertical and horizontal compressor cylinders saves valuable floor space and has exceptionally smooth running balance. The unit has machine-mounted two-stage intercoolers and separate Ingersoll-Rand VM-2 vertical aftercoolers.

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C. VAN DEN BERG is retiring as vice chairman of the board of Southern Natural Gas Co., Birmingham, ending 33 years of service with the company and its affiliates. The office held by van den Berg will be discontinued. Four of Southern Natural's vice presidents—HOWARD M. ERSKINE, H. E. JACKSON, JOHN M. STARKE, and O. W. CLARK, have been promoted to the newly created office of senior vice president. Also, four other executives were elected vice presidents. They are: WILLIAM S. TARVER, L. N. BROWN, ROBERT G. KENAN, and MORTIMER JORDAN. Newly elected assistant treasurer is HOWARD MAXTON. Erskine continues as financial vice president, Jackson continues to serve as treasurer, Starke continues to have general supervision of the oil and gas and gas supply division, and Clark continues to head operations and engineering. Tarver also has the title of general attorney and secretary; Brown, chief engineer; Kenan, director of industrial relations and insurance; and Jordan, director of public relations and industrial development.

Trunkline Gas Co., Houston, has promoted three men in its production and supply department to newly created posts. District managers of exploration are: RAYMOND E. FAIRCHILD, Houston; ROBERT H. DICKERSON, Corpus Christi; and WALLACE K. COX, Lafayette.

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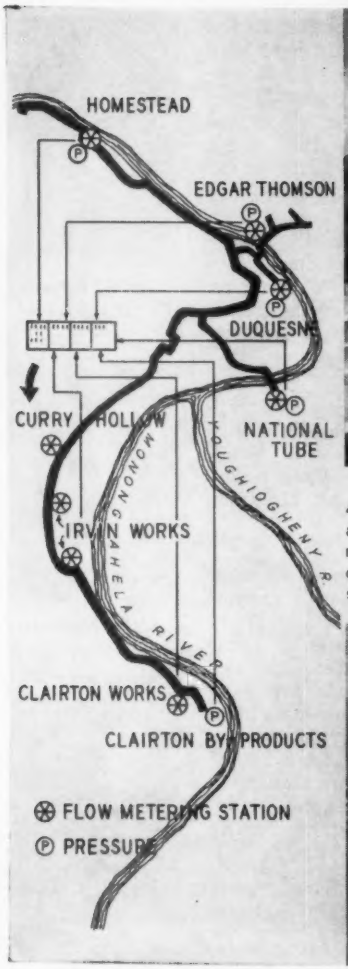

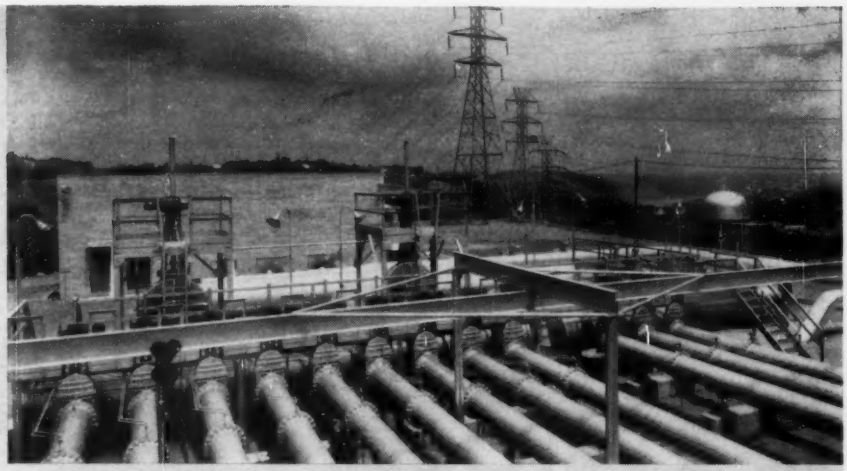

▲ **NINE METER RUNS** for coke-oven gas (left) and three for natural gas (right) at Carnegie's Curry Hollow Station give telemetering system part of its information. Coke-oven gas arrives at Curry Hollow in 55" mains, said to be largest in world.

BRISTOL METAMETER* telemetering instruments (panels at right and rear), in Curry Hollow Station of Carnegie Natural Gas Company, give dispatcher the continuous, up-to-the-second information he needs to control gas flow to six U.S. Steel plants along the Monongahela River. (See map.) ▼

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At Curry Hollow (see map), Carnegie mixes natural gas from company-owned fields to supplement artificial gas produced at the Clairton By-Product Coke Works. Some of the coke-oven gas is used at the Clairton and Irvin Steel works. The mixed gas is supplied to the remaining plants.

The Bristol telemetering system measures individual gas flows and pressures in every main. Individual flows are totalized at Homestead, Irvin, Duquesne, and Edgar Thomson Works and transmitted to the dispatcher's office in Curry Hollow. At Curry Hollow, the Irvin and Clairton Steel Works flows are again totalized with the flow in the 55-inch mains from Clairton to secure the total coke-oven gas output.

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C. JAMES BULLA, JAMES P. COYLE and RICHARD L. TORCZON have been promoted to gas buyers by Northern Natural Gas Co., Omaha. These are newly created posts. Bulla has been a staff assistant. Both Coyle and Torczon were gas purchase engineers.

C. E. UPSON, general superintendent of communications, Natural Gas Pipe Line Co. of America, Chicago, is president of the Petroleum Industry Electrical Association.

G. W. PRAGER has joined Standard Pipeprotection Inc., St. Louis, as a sales representative. Headquartered in Denver, Prager covers Colorado, Wyoming, Montana, Utah, and Idaho.

WILLIAM A. ROEVER is manager of Clark Bros. Co.'s newly created Dallas district office. His territory includes the central part of Texas and part of New Mexico. Included in the new Dallas district organization is creation of a new sales office at Midland. BEN STUART is in charge with HAROLD GENE SMITH as application engineer and A. J. FOSTER as parts salesman. Manager of the new district service office in Midland is BILLIE JOE HARDIN.

ROBERT E. JOHNSTON JR. is assistant sales manager of Cal-Metal Pipe Corp., Baton Rouge. Before his promotion, Johnston was southern district sales manager. DICK A. HALL has joined the company as sales engineer. He headquarters at the home office.

DR. FRANK L. PADGITT has joined Tennessee Gas Transmission Co., Houston, in the newly created post of director of project development. Dr. Padgitt has been manager of vinyl chloride operations in the manufacturing department at Ethyl Corp. since 1956. At TGT his duties will be connected with expansion and diversification plans in the field of hydrocarbon utilization and petrochemicals.

RUSSELL T. TUTT, trustee of the El Pomar Foundation in Colorado Springs, has been elected to the board of directors of Colorado Interstate Gas Co.

LAWRENCE N. HOLDEN JR. is product manager in the Industrial Chemicals division of Pittsburgh Chemical Co.

J. C. Bulla
Northern

R. L. Torczon
Northern

J. P. Coyle
Northern

W. A. Roever
Clark

G. W. Prager
Standard

L. D. Hall
Tube Turns

J. A. Wiendl
Ingersoll

JOSEPH A. WIENDL has been promoted from assistant to general manager of sales for Ingersoll-Rand Co., New York. Wiendl has been with Ingersoll-Rand since 1941.

LINCOLN D. HALL is manager of Tube Turns' newly created Midwest district in Kansas City, Mo. The 10-state territory includes Colorado, Kansas, Missouri, Nebraska, the Dakotas, Wyoming, and parts of Illinois, Iowa, and Montana.

JAMES H. BEWS has been named manager of Clark Bros. Co.'s San Francisco branch office. Bews joined Clark in 1951 and most recently was a sales engineer in the company's Los Angeles district office. His new territory includes San Francisco and the Pacific Northwest.

F. H. Maloney Co., Houston, has two new directors. They are B. HUNTER LOFTIN, partner in the law firm of Butler, Binion, Rice & Cook, and RAY F. WESTON JR., who was also named secretary-treasurer of Maloney. WILLIAM B. CAMPBELL, technical services director for Maloney, was promoted to vice president, technical services.

LOUIS A MERTZ is senior vice president and EDWARD T. FITCH is vice president, financial, of Dravo Corp., Pittsburgh.

James Bews
Clark

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